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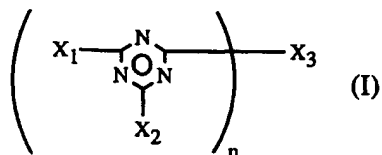
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Piperidine compounds for use as stabilizers for organic materials.

The present invention relates to novel piperidine compounds of the formula (I)



in which X₁, X₂, X₃ and n are as defined in the text.

The compounds of the invention can be used as light stabilizers, heat stabilizers and oxidation stabilizers for organic materials, in particular synthetic polymers.

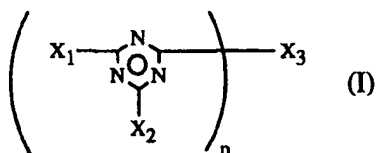
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The present invention relates to novel piperidine compounds, to their use as light stabilizers, heat stabilizers and oxidation stabilizers for organic materials, in particular synthetic polymers, and to the organic materials thus stabilized.

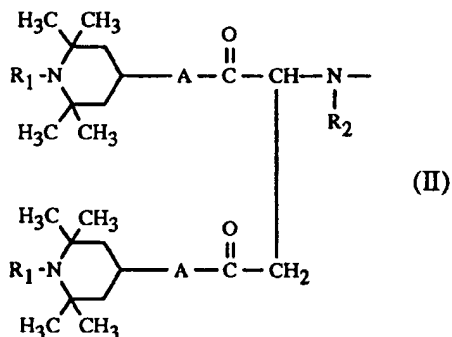
US-A-4 883 831 and US-A-4 883 860 claim the stabilization of synthetic polymers with certain piperidine esters of triazinylamino acids.

In US-A-4 102 858, certain piperidine esters of aspartic acid are reported as stabilizers for synthetic polymers.

The present invention relates to novel compounds of the formula (I)



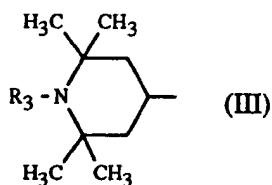
in which X_1 and X_2 which can be identical or different are a group of the formula (II)



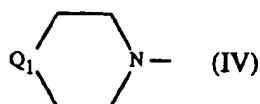
in which

R_1 is hydrogen, C_1 - C_8 alkyl, O, OH, CH_2CN , C_1 - C_{18} alkoxy, C_5 - C_{12} cycloalkoxy, C_3 - C_6 -alkenyl, C_7 - C_9 phenylalkyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C_1 - C_4 alkyl; or aliphatic C_1 - C_8 acyl,

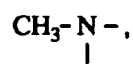
R_2 is hydrogen, C_1 - C_{18} alkyl, C_5 - C_{12} cycloalkyl unsubstituted or mono-, di- or tri-substituted by C_1 - C_4 alkyl; C_7 - C_9 phenylalkyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C_1 - C_4 alkyl; tetrahydrofurfuryl or a group of the formula (III)



where R_3 is as defined for R_1 or C_2 - C_4 alkyl substituted in the 2-, 3- or 4-position by C_1 - C_8 alkoxy, by di(C_1 - C_4 alkyl)amino or by a group of the formula (IV)



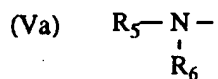
where Q_1 is a direct bond, -O-, - CH_2 -, - CH_2CH_2 - or



5 and A is -O- or



10 with R_4 being hydrogen or C_1 - C_{12} alkyl, or X_1 and X_2 are a group of the formula (IV) or one of the groups of the formulae (Va)-(Ve)

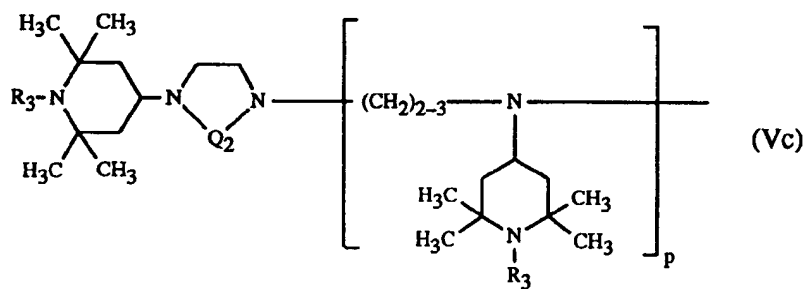


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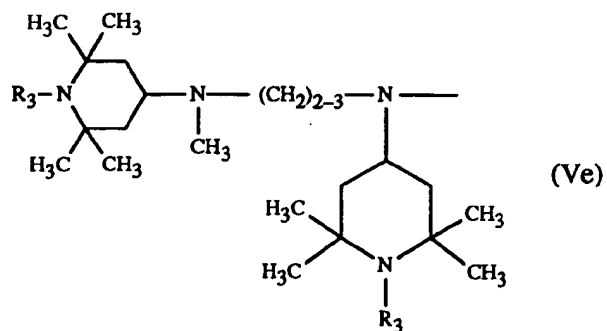
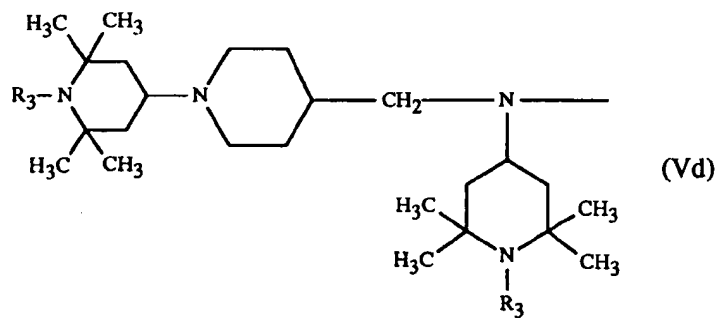
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in which

R_3 is as defined above,

R_5 , R_6 and R_7 which can be identical or different are as defined for R_2 , or R_7 is also C_3 - C_{18} alkenyl or phenyl unsubstituted or mono-, di- or tri-substituted by C_1 - C_4 alkyl or C_1 - C_4 alkoxy;

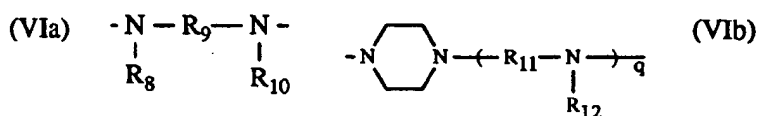
5 Q_2 is $-\text{CO}-$, $-\text{CH}_2\text{CH}_2-$, $-\text{COCO}-$, $-\text{CH}_2\text{CO}-$ or $-\text{COCH}_2\text{CO}-$ and

p is zero or 1,

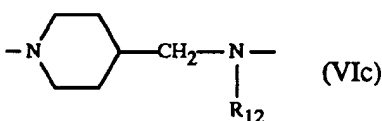
n is 1, 2, 3 or 4 and,

if n is 1, X_3 is as defined for X_1 and X_2 , and, if n is 2, X_3 is one of the formulae (VIa)-(VIc)

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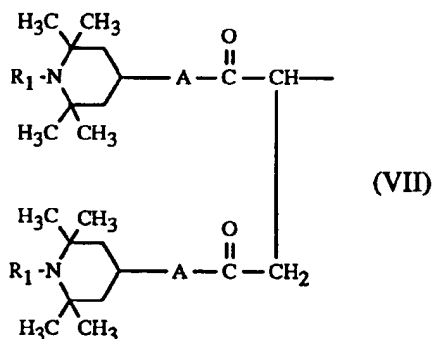
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in which

R_8 , R_{10} and R_{12} which can be identical or different are as defined for R_2 , or R_8 and R_{10} are also a group of the formula (VII)

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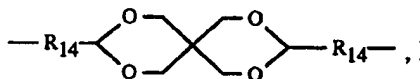
with R_1 and A as defined above, R_9 is C_2 - C_{12} alkylene, C_5 - C_7 cycloalkylene, C_5 - C_7 cycloalkylenedi(C_1 - C_4 alkylene), C_1 - C_4 alkylenedi(C_5 - C_7 cycloalkylene), phenylenedi(C_1 - C_4 alkylene) or C_4 - C_{12} alkylene interrupted by a 1,4-piperazinediyl group or by 1, 2 or 3 oxygen atoms or by 1 or 2

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groups, where R_{13} is as defined for R_2 or is aliphatic C_1 - C_{12} acyl or (C_1 - C_{12} alkoxy)carbonyl, or R_9 is also a group

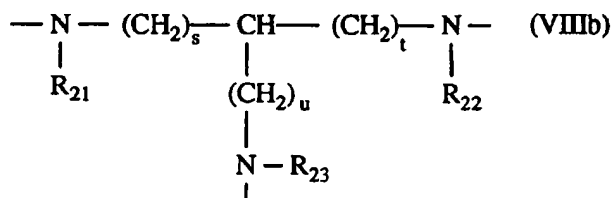
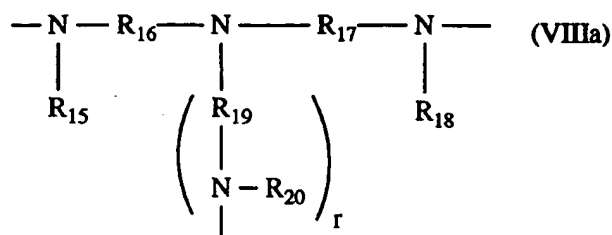
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R_{11} and R_{14} are C_2 - C_6 alkylene and

q is zero or 1, and

55 if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb)



in which

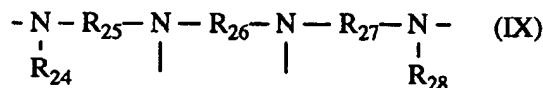
R₁₅, R₁₈, R₂₀, R₂₁, R₂₂ and R₂₃ which can be identical or different are as defined above for R₈ and R₁₀,

R₁₆, R₁₇ and R₁₉ which can be identical or different are C₂-C₆alkylene,

r and u are zero or 1, and

s and t which can be identical or different are integers from 2 to 6, and,

if n is 4, X₃ is a group of the formula (IX)



in which

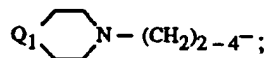
R₂₄ and R₂₈ which can be identical or different are as defined above for R₈ and R₁₀, and R₂₅, R₂₆ and R₂₇ which can be identical or different are C₂-C₆alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

Examples of alkyl having not more than 18 carbon atoms are methyl, ethyl, propyl, isopropyl, butyl, 2-butyl, isobutyl, t-butyl, pentyl, 2-pentyl, hexyl, heptyl, octyl, 2-ethylhexyl, t-octyl, nonyl, decyl, undecyl, dodecyl, tridecyl, tetradecyl, hexadecyl and octadecyl.

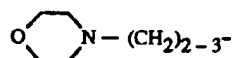
Examples of C₂-C₄alkyl substituted by C₁-C₈alkoxy, preferably by C₁-C₄alkoxy, in particular methoxy or ethoxy, are 2-methoxyethyl, 2-ethoxyethyl, 3-methoxypropyl, 3-ethoxypropyl, 3-butoxypropyl, 3-octoxypropyl and 4-methoxybutyl.

Examples of C₂-C₄alkyl substituted by di(C₁-C₄alkyl)amino, preferably by dimethylamino or diethylamino, are 2-dimethylaminoethyl, 2-diethylaminoethyl, 3-dimethylaminopropyl, 3-diethylaminopropyl, 3-dibutylaminopropyl and 4-diethylaminobutyl.

Preferred examples of C₂-C₄alkyl substituted by a group of the formula (IV) are the groups



the group



is particularly preferred.

Examples of alkoxy having not more than 18 carbon atoms are methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, pentoxy, isopentoxy, hexoxy, heptoxy, octoxy, decyloxy, dodecyloxy, tetradecyloxy, hexadecyloxy and octadecyloxy. Preferred examples of R_1 and R_3 are C_6 - C_{12} alkoxy, in particular heptoxy and octoxy.

Examples of C_5 - C_{12} cycloalkyl unsubstituted or mono-, di- or tri-substituted by C_1 - C_4 alkyl are cyclopentyl, methylcyclopentyl, dimethylcyclopentyl, cyclohexyl, methylcyclohexyl, dimethylcyclohexyl, trimethylcyclohexyl, t-butylcyclohexyl, cyclooctyl, cyclodecyl and cyclododecyl. Unsubstituted or substituted cyclohexyl is preferred.

Examples of C_5 - C_{12} cycloalkoxy R_1 and R_3 are cyclopentoxy, cyclohexoxy, cycloheptoxy, cyclooctoxy, cyclodecyloxy and cyclododecyloxy. Cyclopentoxy and cyclohexoxy are preferred.

Examples of alkenyl having not more than 18 carbon atoms are allyl, 2-methylallyl, butenyl, hexenyl, undecenyl and octadecenyl. Alkenyls in which the carbon atom in the 1-position is saturated are preferred; allyl is particularly preferred.

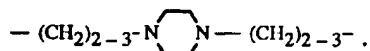
Representative examples of phenyl mono-, di- or tri-substituted by C_1 - C_4 alkyl or C_1 - C_4 -alkoxy are methylphenyl, dimethylphenyl, trimethylphenyl, t-butylphenyl, di-t-butylphenyl, 3,5-di-t-butyl-4-methylphenyl, methoxyphenyl, ethoxyphenyl and butoxyphenyl.

Examples of C_7 - C_9 phenylalkyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C_1 - C_4 alkyl are benzyl, methylbenzyl, dimethylbenzyl, trimethylbenzyl, 2-butylbenzyl and 2-phenylethyl. Benzyl is preferred.

Representative examples of aliphatic acyl having not more than 12 carbon atoms are acetyl, propionyl, butyryl, isobutyryl, pentanoyl, hexanoyl, heptanoyl, octanoyl, 2-ethylhexanoyl, decanoyl, undecanoyl, dodecanoyl, acryloyl, crotonyl and 10-undecenoyl. C_1 - C_8 Alkanoyl and C_3 - C_8 alkenoyl are particularly preferred.

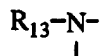
Examples of alkylene having not more than 12 carbon atoms are ethylene, propylene, trimethylene, 2-methyltrimethylene, 2,2-dimethyltrimethylene, tetramethylene, pentamethylene, hexamethylene, trimethylhexamethylene, octamethylene, decamethylene and dodecamethylene.

A preferred example of C_4 - C_{12} alkylene R_9 interrupted by a 1,4-piperazinediyl group is the group

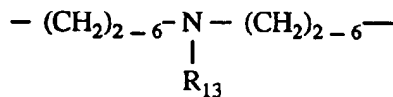


Examples of C_4 - C_{12} alkylene interrupted by 1, 2 or 3 oxygen atoms are 4-oxaheptane-1,7-diyl, 4,7-dioxadecane-1,10-diyl, 4,9-dioxadodecane-1,12-diyl and 4,7,10-trioxatridecane-1,13-diyl.

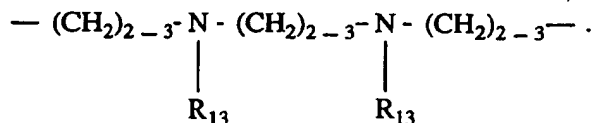
Representative examples of C_4 - C_{12} alkylene R_9 interrupted by 1 or 2



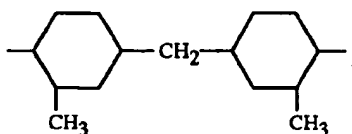
groups are the groups



and



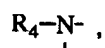
Representative examples of groups having 1 or 2 C_5 - C_7 cycloalkylene groups are cyclohexylene, methylcyclohexylene, cyclohexylenedimethylene, methylenedicyclohexylene and the group



Phenylenedimethylene is the preferred example of phenylenedi(C₁-C₄alkylene).

Preferred definitions of R₁ and R₃ are hydrogen, C₁-C₄alkyl, OH, C₆-C₁₂alkoxy, C₅-C₈-cycloalkoxy, allyl, benzyl or acetyl, in particular hydrogen or methyl.

Those compounds of the formula (I) are preferred in which X₁ and X₂ which can be identical or different are a group of the formula (II) in which R₂ is hydrogen, C₁-C₁₆alkyl, C₅-C₈cycloalkyl unsubstituted or mono-, di- or tri-substituted by C₁-C₄alkyl; benzyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C₁-C₄alkyl; tetrahydrofurfuryl, a group of the formula (III), C₂-C₃alkyl substituted in the 2- or 3-position by C₁-C₄alkoxy, by di-(C₁-C₄alkyl)amino or by a group of the formula (IV), where Q₁ is a direct bond, -O-, -CH₂- or -CH₂CH₂-, and A is -O- or



with R₄ being hydrogen or C₁-C₁₀alkyl, or X₁ and X₂ are a group of the formula (IV) or one of the groups of the formulae (Va)-(Ve), in which R₅, R₆ and R₇ which can be identical or different are as defined for R₂, or R₇ is also C₃-C₁₂alkenyl or phenyl unsubstituted or mono-, di- or tri-substituted by C₁-C₄alkyl or C₁-C₄alkoxy, Q₂ is -CO-, -CH₂CH₂-, -COCO- or -COCH₂CO-, p is zero or 1 and n is 1, 2, 3 or 4, and, if n is 1, X₃ is as defined for X₁ and X₂, and, if n is 2, X₃ is one of the groups of the formulae (VIa)-(VIc) in which R₈, R₁₀ and R₁₂ which can be identical or different are as defined above for R₂ or R₈ and R₁₀ are also a group of the formula (VII), R₉ is C₂-C₁₀alkylene, cyclohexylene, cyclohexylenedimethylene, methylenedicyclohexylene, phenylenedimethylene, C₄-C₁₀alkylene interrupted by a 1,4-piperazinediyl group or by 1, 2 or 3 oxygen atoms or by 1 or 2



groups, where R₁₃ is as defined above for R₂ or is aliphatic C₁-C₈acyl or (C₁-C₈alkoxy)carbonyl, or R₉ is also a group



R₁₁ and R₁₄ are C₂-C₄alkylene and q is zero or 1, and, if n is 3, X₃ is a group of the formula (VIIIa) or (VIIIb), in which R₁₅, R₁₈, R₂₀, R₂₁, R₂₂ and R₂₃ which can be identical or different are as defined above for R₈ and R₁₀, R₁₆, R₁₇ and R₁₉ which can be identical or different are C₂-C₄alkylene, r and u are zero or 1 and s and t which can be identical or different are integers from 3 to 6 and, if n is 4, X₃ is a group of the formula (IX) in which R₂₄ and R₂₈ which can be identical or different are as defined above for R₈ and R₁₀, and R₂₅, R₂₆ and R₂₇ which can be identical or different are C₂-C₄alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

Those compounds of the formula (I) are particularly preferred in which X₁ and X₂ which can be identical or different are a group of the formula (II), where R₂ is hydrogen, C₁-C₁₄alkyl, cyclohexyl unsubstituted or mono-, di- or tri-substituted by C₁-C₄alkyl; benzyl, tetrahydrofurfuryl, a group of the formula (III), C₂-C₃alkyl substituted in the 2- or 3-position by methoxy, by ethoxy, by dimethylamino, by diethylamino or by a 4-morpholinyl group, and A is -O- or



with R₄ being hydrogen or C₁-C₈alkyl, or X₁ and X₂ are a 4-morpholinyl group or one of the groups of the formulae (Va)-(Ve) in which R₅, R₆ and R₇ which can be identical or different are as defined above for R₂, or R₇ is also C₃-C₁₁-alkenyl or phenyl, Q₂ is -CO-, -CH₂CH₂- or -COCO-, p is zero or 1 and n is 1, 2, 3 or 4, and if n is 1, X₃ is as defined above for X₁ and X₂, and, if n is 2, X₃ is one of the groups of the formulae (VIa)-(VIc) in which R₈, R₁₀ and R₁₂ which can be identical or different are as defined above for R₂, or R₈ and R₁₀ are also a group of the formula (VII), R₉ is C₂-C₈alkylene, cyclohexylenedimethylene, methylenedicyclohexylene or phenylenedimethylene, C₄-C₁₀alkylene interrupted by a 1,4-piperazinediyl group or by 1, 2 or 3 oxygen atoms

or by 1 or 2



groups, where R_{13} is as defined above for R_2 or is aliphatic C_1 - C_4 acyl or (C_1 - C_4 alkoxy)carbonyl, or R_9 is also a group

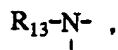


R_{11} and R_{14} are C_2 - C_4 alkylene and q is zero or 1, and, if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb) in which R_{15} , R_{18} , R_{20} , R_{21} , R_{22} and R_{23} which can be identical or different are as defined above for R_8 and R_{10} , R_{16} , R_{17} and R_{19} which can be identical or different are C_2 - C_4 alkylene, r and u are zero or 1 and s and t which can be identical or different are integers from 3 to 5, and, if n is 4, X_3 is a group of the formula (IX) in which R_{24} and R_{28} which can be identical or different are as defined above for R_8 and R_{10} , and R_{25} , R_{26} and R_{27} which can be identical or different are C_2 - C_4 alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

Those compounds of the formula (I) are of special interest in which X_1 and X_2 which can be identical or different are a group of the formula (II), where R_2 is hydrogen, C_1 - C_{12} -alkyl, cyclohexyl or a group of the formula (III) and A is -O- or

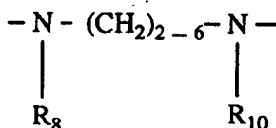


with R_4 being hydrogen or C_1 - C_4 alkyl, or X_1 and X_2 are a 4-morpholinyl group or one of the groups of the formulae (Va)-(Ve) in which R_5 , R_6 and R_7 which can be identical or different are as defined above for R_2 , Q_2 is -CO- or - CH_2CH_2 -, p is zero or 1 and n is 1, 2, 3 or 4, and, if n is 1, X_3 is as defined above for X_1 and X_2 , and, if n is 2, X_3 is one of the groups of the formulae (VIa)-(VIc) in which R_8 , R_{10} and R_{12} which can be identical or different are as defined above for R_2 , or R_8 and R_{10} are also a group of the formula (VII), R_9 is C_2 - C_8 -alkylene, cyclohexylenedimethylene, methylenedicyclohexylene, C_6 - C_{10} alkylene interrupted by a 1,4-piperazinediyl group or by 2 or 3 oxygen atoms or by a group

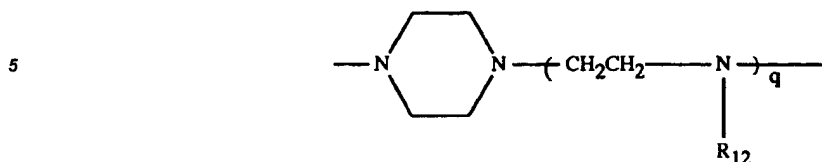


where R_{13} is as defined above for R_2 , R_{11} is C_2 - C_3 alkylene and q is zero or 1, and, if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb) in which r is zero, R_{15} , R_{18} , R_{21} , R_{22} and R_{23} , which can be identical or different are as defined above for R_8 and R_{10} , R_{16} and R_{17} which can be identical or different are C_2 - C_3 alkylene, u is zero or 1 and s and t which can be identical or different are integers from 3 to 5, and, if n is 4, X_3 is a group of the formula (IX) in which R_{24} and R_{28} which can be identical or different are as defined above for R_8 and R_{10} , and R_{25} , R_{26} and R_{27} which can be identical or different are C_2 - C_3 alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

Those compounds of the formula (I) are of particular interest in which X_1 and X_2 which can be identical or different are a group of the formula (II), where R_1 is hydrogen or methyl, R_2 is C_1 - C_8 alkyl, cyclohexyl, 2,2,6,6-tetramethyl-4-piperidyl or 1,2,2,6,6-pentamethyl-4-piperidyl and A is -O-, or X_1 and X_2 are a group of the formula (Va) or (Vb), in which R_5 and R_6 which can be identical or different are as defined above for R_2 , and R_7 , is 2,2,6,6-tetramethyl-4-piperidyl or 1,2,2,6,6-pentamethyl-4-piperidyl and n is 1, 2, 3 or 4, and, if n is 1, X_3 is as defined above for X_1 and X_2 , and, if n is 2, X_3 is a group

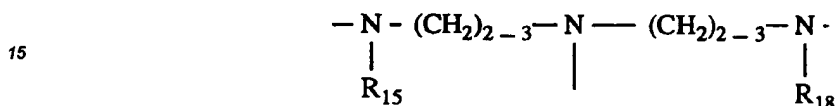


or a group



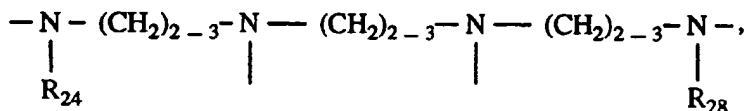
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in which R_8 , R_{10} and R_{12} which can be identical or different are as defined above for R_2 or are hydrogen, or R_8 and R_{10} are also a group of the formula (VII), and q is zero or 1, and, if n is 3, X_3 is a group



and, if n is 4, X_3 is a group

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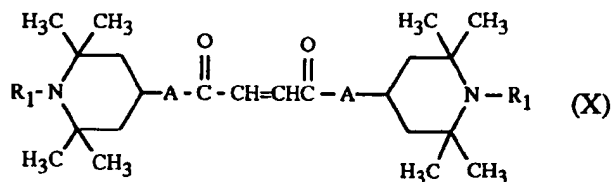
with R_{15} , R_{18} , R_{24} and R_{28} being as defined above for R_8 and R_{10} , with the proviso that at least one group of the formula (II) or the formula (VII) is present in the compounds of the formula (I).

The compounds of the present invention can be prepared by diverse processes known per se, like e.g. outlined in US-A-4 108 829; US-A-4 263 434; US-A-4 883 860; US-A-4 883 831 or US-A-4 102 858.

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According to process A, a dipiperidyl derivative of maleic or fumaric acid of the formula (X)

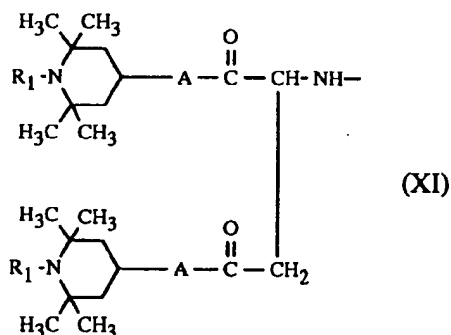
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is added in a first stage to a suitable amine containing at least one NH_2 group, to obtain a compound containing one or more groups of the formula (XI)

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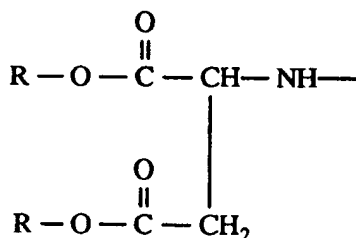
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The reaction is carried out in an inert organic solvent, for example toluene, xylene, $\text{C}_1\text{--C}_6$ -alkanol, tetrahydrofuran, dioxane or dimethylformamide at a temperature from 0° to 150°C , preferably from 10° to 120°C .

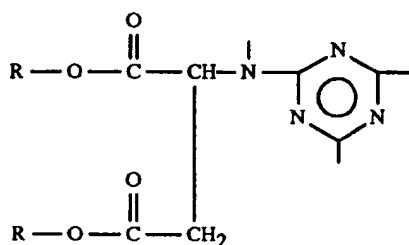
In a subsequent stage, the dipiperidyl derivatives of aspartic acid thus obtained are reacted in any order and in the appropriate molar ratios with cyanuric chloride and other suitable reagents to obtain the compounds of the formula (I). The reaction is carried out in an inert organic solvent, for example toluene, xylene, trimethylbenzene, t-amyl alcohol or mixtures thereof, in any proportions of t-amyl alcohol with the abovementioned hydrocarbons, in the presence of a preferably inorganic base such as sodium or potassium hydroxide or carbonate at a temperature from -20° to 200°C, preferably from -10° to 180°C.

According to process B, compounds containing one or more groups of the formula

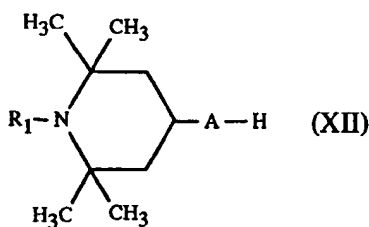


where R is C₁-C₄alkyl are first prepared by adding a di(C₁-C₄alkyl) maleate or fumarate to a suitable amine containing at least one NH₂ group, by means of known procedures.

In a subsequent stage, the di(C₁-C₄alkyl) aspartates thus obtained are reacted in any order and in the appropriate molar ratios with cyanuric chloride and other suitable reagents, following the procedure of process A, to obtain compounds containing one or more groups of the formula



which are finally reacted with the appropriate molar quantity of a compound of the formula (XII)



in the presence of a catalyst such as an alkali metal, a C₁-C₄alkoxide or amide or hydride of an alkali metal, a C₁-C₄alkoxide of Ti(IV) or dibutyltin oxide, the reaction being carried out in the absence of a solvent or in an inert organic solvent, for example toluene, xylene or trimethylbenzene at a temperature from 100° to 200°C, preferably from 110° to 180°C.

When working according to process B, if A is -O-, it is possible in the reaction with cyanuric chloride to use a compound of the formula (XII) in which A is -O- as temporary acceptor for the hydrochloric acid released, the resulting hydrochloride then being neutralized with a hydroxide or a C₁-C₄alkoxide of sodium or potassium to re-form the free base which thus becomes available for the transesterification reaction.

According to process C, the di(C₁-C₄alkyl) aspartates prepared as shown under process B are reacted with the appropriate molar quantity of a compound of the formula (XII) as indicated in process B to obtain compounds containing one or more groups of the formula (XI), which are finally reacted in any order and in the appropriate molar ratios with cyanuric chloride and other reagents, following the procedure of process A, to obtain the com-

pounds of the formula (I).

The various stages of the different reactions can be carried out in a single reactor or in the same solvent or in different solvents, without isolating the intermediates or after separating and, if desired, purifying them.

The compounds of the formulae (X) and (XII) can be prepared by known processes; the other reagents
5 are commercially available or can be prepared according to the state of the art.

As mentioned at the outset, the compounds of the present invention are highly effective in improving the light stability, heat stability and oxidation stability of organic materials, in particular synthetic polymers and copolymers, and are particularly suitable for stabilizing polypropylene fibres.

10 Examples of organic materials which can be stabilized are:

1. Polymers of monoolefins and diolefins, for example polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyisoprene or polybutadiene, as well as polymers of cycloolefins, for instance
15 of cyclopentene or norbornene, polyethylene (which optionally can be crosslinked), for example high density polyethylene (HDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), branched low density polyethylene (BLDPE).

Polyolefins, i.e. the polymers of monoolefins exemplified in the preceding paragraph, preferably polyethylene and polypropylene, can be prepared by different, and especially by the following, methods:

a) radical polymerisation (normally under high pressure and at elevated temperature).
20 b) catalytic polymerisation using a catalyst that normally contains one or more than one metal of groups IVb, Vb, Vlb or VIII of the Periodic Table. These metals usually have one or more than one ligand, typically oxides, halides, alcoholates, esters, ethers, amines, alkyls, alkenyls and/or aryls that may be either π - or σ -coordinated. These metal complexes may be in the free form or fixed on substrates, typically on activated magnesium chloride, titanium(III) chloride, alumina or silicon oxide. These catalysts may
25 be soluble or insoluble in the polymerisation medium. The catalysts can be used by themselves in the polymerisation or further activators may be used, typically metal alkyls, metal hydrides, metal alkyl halides, metal alkyl oxides or metal alkyl oxanes, said metals being elements of groups Ia, IIa and/or IIIa of the Periodic Table. The activators may be modified conveniently with further ester, ether, amine or silyl ether groups. These catalyst systems are usually termed Phillips, Standard Oil Indiana, Ziegler (-Natta),
30 TNZ (DuPont), metallocene or single site catalysts (SSC).

2. Mixtures of the polymers mentioned under 1), for example mixtures of polypropylene with polyisobutylene, polypropylene with polyethylene (for example PP/HDPE, PP/LDPE) and mixtures of different types of polyethylene (for example LDPE/HDPE).

3. Copolymers of monoolefins and diolefins with each other or with other vinyl monomers, for example
35 ethylene/propylene copolymers, linear low density polyethylene (LLDPE) and mixtures thereof with low density polyethylene (LDPE), propylene/but-1-ene copolymers, propylene/isobutylene copolymers, ethylene/but-1-ene copolymers, ethylene/hexene copolymers, ethylene/methylpentene copolymers, ethylene/heptene copolymers, ethylene/octene copolymers, propylene/butadiene copolymers, isobutylene/isoprene copolymers, ethylene/alkyl acrylate copolymers, ethylene/alkyl methacrylate copolymers, ethylene/vinyl acetate copolymers and their copolymers with carbon monoxide or ethylene/acrylic acid copolymers and their salts (ionomers) as well as terpolymers of ethylene with propylene and a diene such as hexadiene, dicyclopentadiene or ethylidene-norbornene; and mixtures of such copolymers with one another and with polymers mentioned in 1) above, for example polypropylene/ethylene-propylene copolymers, LDPE/ethylene-vinyl acetate copolymers (EVA), LDPE/ethylene-acrylic acid copolymers (EAA),
45 LLDPE/EVA, LLDPE/EAA and alternating or random polyalkylene/carbon monoxide copolymers and mixtures thereof with other polymers, for example polyamides.

4. Hydrocarbon resins (for example C_5 - C_9) including hydrogenated modifications thereof (e.g. tackifiers) and mixtures of polyalkylenes and starch.

5. Polystyrene, poly(p-methylstyrene), poly(α -methylstyrene).

6. Copolymers of styrene or α -methylstyrene with dienes or acrylic derivatives, for example styrene/butadiene, styrene/acrylonitrile, styrene/alkyl methacrylate, styrene/butadiene/alkyl acrylate, styrene/butadiene/alkyl methacrylate, styrene/maleic anhydride, styrene/acrylonitrile/methyl acrylate; mixtures of high impact strength of styrene copolymers and another polymer, for example a polyacrylate, a diene polymer or an ethylene/-propylene/diene terpolymer; and block copolymers of styrene such as styrene/butadiene/-styrene, styrene/isoprene/styrene, styrene/ethylene/butylene/styrene or styrene/ethylene/-propylene/styrene.
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7. Graft copolymers of styrene or α -methylstyrene, for example styrene on polybutadiene, styrene on polybutadiene-styrene or polybutadiene-acrylonitrile copolymers; styrene and acrylonitrile (or methacrylonitrile)

- trile) on polybutadiene; styrene, acrylonitrile and methyl methacrylate on polybutadiene; styrene and maleic anhydride on polybutadiene; styrene, acrylonitrile and maleic anhydride or maleimide on polybutadiene; styrene and maleimide on polybutadiene; styrene and alkyl acrylates or methacrylates on polybutadiene; styrene and acrylonitrile on ethylene/propylene/diene terpolymers; styrene and acrylonitrile on polyalkyl acrylates or polyalkyl methacrylates, styrene and acrylonitrile on acrylate/butadiene copolymers, as well as mixtures thereof with the copolymers listed under 6), for example the copolymer mixtures known as ABS, MBS, ASA or AES polymers.
8. Halogen-containing polymers such as polychloroprene, chlorinated rubbers, chlorinated or sulfochlorinated polyethylene, copolymers of ethylene and chlorinated ethylene, epi-chlorohydrin homo- and copolymers, especially polymers of halogen-containing vinyl compounds, for example polyvinyl chloride, polyvinylidene chloride, polyvinyl fluoride, polyvinylidene fluoride, as well as copolymers thereof such as vinyl chloride/vinylidene chloride, vinyl chloride/vinyl acetate or vinylidene chloride/vinyl acetate copolymers.
9. Polymers derived from α,β -unsaturated acids and derivatives thereof such as polyacrylates and polymethacrylates; polymethyl methacrylates, polyacrylamides and polyacrylonitriles, impact-modified with butyl acrylate.
10. Copolymers of the monomers mentioned under 9) with each other or with other unsaturated monomers, for example acrylonitrile/butadiene copolymers, acrylonitrile/alkyl acrylate copolymers, acrylonitrile/alkoxyalkyl acrylate or acrylonitrile/vinyl halide copolymers or acrylonitrile/alkyl methacrylate/butadiene terpolymers.
11. Polymers derived from unsaturated alcohols and amines or the acyl derivatives or acetals thereof, for example polyvinyl alcohol, polyvinyl acetate, polyvinyl stearate, polyvinyl benzoate, polyvinyl maleate, polyvinyl butyral, polyallyl phthalate or polyallyl melamine; as well as their copolymers with olefins mentioned in 1) above.
12. Homopolymers and copolymers of cyclic ethers such as polyalkylene glycols, polyethylene oxide, polypropylene oxide or copolymers thereof with bisglycidyl ethers.
13. Polyacetals such as polyoxymethylene and those polyoxymethylenes which contain ethylene oxide as a comonomer; polyacetals modified with thermoplastic polyurethanes, acrylates or MBS.
14. Polyphenylene oxides and sulfides, and mixtures of polyphenylene oxides with styrene polymers or polyamides.
15. Polyurethanes derived from hydroxyl-terminated polyethers, polyesters or polybutadienes on the one hand and aliphatic or aromatic polyisocyanates on the other, as well as precursors thereof.
16. Polyamides and copolyamides derived from diamines and dicarboxylic acids and/or from aminocarboxylic acids or the corresponding lactams, for example polyamide 4, polyamide 6, polyamide 6/6, 6/10, 6/9, 6/12, 4/6, 12/12, polyamide 11, polyamide 12, aromatic polyamides starting from m-xylene diamine and adipic acid; polyamides prepared from hexamethylenediamine and isophthalic or/and terephthalic acid and with or without an elastomer as modifier, for example poly-2,4,4'-trimethylhexamethylene terephthalamide or poly-m-phenylene isophthalamide; and also block copolymers of the aforementioned polyamides with polyolefins, olefin copolymers, ionomers or chemically bonded or grafted elastomers; or with polyethers, e.g. with polyethylene glycol, polypropylene glycol or polytetramethylene glycol; as well as polyamides or copolyamides modified with EPDM or ABS; and polyamides condensed during processing (RIM polyamide systems).
17. Polyureas, polyimides, polyamide-imides and polybenzimidazoles.
18. Polyesters derived from dicarboxylic acids and diols and/or from hydroxycarboxylic acids or the corresponding lactones, for example polyethylene terephthalate, polybutylene terephthalate, poly-1,4-dimethylolcyclohexane terephthalate and polyhydroxybenzoates, as well as block copolyether esters derived from hydroxyl-terminated polyethers; and also polyesters modified with polycarbonates or MBS.
19. Polycarbonates and polyester carbonates.
20. Polysulfones, polyether sulfones and polyether ketones.
21. Crosslinked polymers derived from aldehydes on the one hand and phenols, ureas and melamines on the other hand, such as phenol/formaldehyde resins, urea/formaldehyde resins and melamine/formaldehyde resins.
22. Drying and non-drying alkyd resins.
23. Unsaturated polyester resins derived from copolyesters of saturated and unsaturated dicarboxylic acids with polyhydric alcohols and vinyl compounds as crosslinking agents, and also halogen-containing modifications thereof of low flammability.
24. Crosslinkable acrylic resins derived from substituted acrylates, for example epoxy acrylates, urethane acrylates or polyester acrylates.
25. Alkyd resins, polyester resins and acrylate resins crosslinked with melamine resins, urea resins, poly-

isocyanates or epoxy resins.

26. Crosslinked epoxy resins derived from polyepoxides, for example from bisglycidyl ethers or from cycloaliphatic diepoxides.

27. Natural polymers such as cellulose, rubber, gelatin and chemically modified homologous derivatives thereof, for example cellulose acetates, cellulose propionates and cellulose butyrates, or the cellulose ethers such as methyl cellulose; as well as rosins and their derivatives.

28. Blends of the aforementioned polymers (polyblends), for example PP/EPDM, Polyamide/EPDM or ABS, PVC/EVA, PVC/ABS, PVC/MBS, PC/ABS, PBTP/ABS, PC/ASA, PC/PBT, PVC/CPE, PVC/acrylates, POM/thermoplastic PUR, PC/thermoplastic PUR, POM/acrylate, POM/MBS, PPO/HIPS, PPO/PA 6.6 and copolymers, PA/HDPE, PA/PP, PA/PPO.

29. Naturally occurring and synthetic organic materials which are pure monomeric compounds or mixtures of such compounds, for example mineral oils, animal and vegetable fats, oil and waxes, or oils, fats and waxes based on synthetic esters (e.g. phthalates, adipates, phosphates or trimellitates) and also mixtures of synthetic esters with mineral oils in any weight ratios, typically those used as spinning compositions, as well as aqueous emulsions of such materials.

30. Aqueous emulsions of natural or synthetic rubber, e.g. natural latex or latices of carboxylated styrene/butadiene copolymers.

The compounds of the formula (I) are particularly suitable for improving the light stability, heat stability and oxidation stability of polyolefins, especially polyethylene and polypropylene.

The invention also relates to compositions comprising an organic material that is susceptible to degradation induced by light, heat and/or oxidation and at least one compound of formula (I).

The compounds of the formula (I) can be used in mixtures with organic materials in various proportions depending on the nature of the material to be stabilized, on the end use and on the presence of other additives.

In general, it is appropriate to use, for example, 0.01 to 5 % by weight of the compounds of the formula (I), relative to the weight of the material to be stabilized, preferably between 0.05 and 1 %.

In general, the compounds of the formula (I) can be added to the polymeric materials before, during or after the polymerization or crosslinking of the said materials.

The compounds of the formula (I) can be incorporated in the polymeric materials in the pure form or encapsulated in waxes, oils or polymers.

The compounds of the formula (I) can be incorporated in the polymeric materials by various processes, such as dry mixing in the form of powder, or wet mixing in the form of solutions or suspensions or also in the form of a masterbatch; in such operations, the polymer can be used in the form of powder, granules, solutions, suspensions or in the form of latices.

The materials stabilized with the products of the formula (I) can be used for the production of mouldings, films, tapes, monofilaments, fibres, surface coatings and the like.

If desired, other conventional additives for synthetic polymers, such as antioxidants, UV absorbers, nickel stabilizers, pigments, fillers, plasticizers, antistatic agents, flameproofing agents, lubricants, corrosion inhibitors and metal deactivators, can be added to the mixtures of the compounds of the formula (I) with the organic materials.

Particular examples of additives which can be used in admixture with the compounds of the formula (I) are:

1. Antioxidants

1.1. Alkylated monophenols, for example 2,6-di-tert-butyl-4-methylphenol, 2-tert-butyl-4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol, 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2-(α -methylcyclohexyl)-4,6-dimethylphenol, 2,6-di-octadecyl-4-methylphenol, 2,4,6-tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol, 2,6-di-nonyl-4-methylphenol, 2,4-dimethyl-6-(1'-methylundec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methylheptadec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methyltridec-1'-yl)phenol and mixtures thereof.

1.2. Alkylthiomethylphenols, for example 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-di-dodecylthiomethyl-4-nonylphenol.

1.3. Hydroquinones and alkylated hydroquinones, for example 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-diphenyl-4-octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyphenyl stearate, bis-(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.

1.4. Tocopherols, for example α -tocopherol, β -tocopherol, γ -tocopherol, δ -tocopherol and mixtures thereof (Vitamin E).

1.5. Hydroxylated thiodiphenyl ethers, for example 2,2'-thiobis(6-tert-butyl-4-methylphenol), 2,2'-thiobis(4-octylphenol), 4,4'-thiobis(6-tert-butyl-3-methylphenol), 4,4'-thiobis(6-tert-butyl-2-methylphenol),

4,4'-thiobis-(3,6-di-sec-amyphenol), 4,4'-bis-(2,6-dimethyl-4-hydroxyphenyl) disulfide.

1.6. Alkylidenebisphenols, for example 2,2'-methylenebis(6-tert-butyl-4-methylphenol), 2,2'-methylenebis(6-tert-butyl-4-ethylphenol), 2,2'-methylenebis[4-methyl-6-(α -methylcyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,2'-methylenebis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol), 2,2'-methylenebis[6-(α -methylbenzyl)-4-nonylphenol], 2,2'-methylenebis[6-(α , α -dimethylbenzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis-(3,5-dimethyl-2-hydroxyphenyl)butane, 2,2-bis-(3,5-di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis-(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1, 1,5,5-tetra-(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.

1.7. O-, N- and S-benzyl compounds, for example 3,5,3',5'-tetra-tert-butyl-4,4'-dihydroxydibenzyl ether, octadecyl-4-hydroxy-3,5-dimethylbenzylmercaptoacetate, tris-(3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithioterephthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl)sulfide, isooctyl-3,5-di-tert-butyl-4-hydroxybenzylmercaptoacetate.

1.8. Hydroxybenzylated malonates, for example dioctadecyl-2,2-bis-(3,5-di-tert-butyl-4-hydroxybenzyl)-malonate, di-octadecyl-2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)-malonate, di-dodecylmercaptoethyl-2,2-bis-(3,5-di-tert-butyl-4-hydroxybenzyl)malonate, bis-[4-(1,1,3,3-tetramethylbutyl)phenyl]-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate.

1.9. Aromatic hydroxybenzyl compounds, for example 1,3,5-tris-(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzene, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)phenol.

1.10. Triazine Compounds, for example 2,4-bis(octylmercapto)-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,2,3-triazine, 1,3,5-tris-(3,5-di-tert-butyl-4-hydroxybenzyl)isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)isocyanurate, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)-hexahydro-1,3,5-triazine, 1,3,5-tris(3,5-dicyclohexyl-4-hydroxybenzyl)isocyanurate.

1.11. Benzylphosphonates, for example dimethyl-2,5-di-tert-butyl-4-hydroxybenzylphosphonate, diethyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-5-tert-butyl-4-hydroxy-3-methylbenzylphosphonate, the calcium salt of the monoethyl ester of 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid.

1.12. Acylaminophenols, for example 4-hydroxylauranilide, 4-hydroxystearanilide, octyl N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamate.

1.13. Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.14. Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.15. Esters of β -(3,5-dicyclohexyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.16. Esters of 3,5-di-tert-butyl-4-hydroxyphenyl acetic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol,

tris(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.17. Amides of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid e.g. N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine.

2. UV absorbers and light stabilisers

2.1.2-(2'-Hydroxyphenyl)benzotriazoles, for example 2-(2'-hydroxy-5'-methylphenyl)-benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chloro-benzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis-(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, mixture of 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-[2-(2-ethylhexyloxy)-carbonylethyl]-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, and 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonylethyl)phenyl)benzotriazole, 2,2'-methylenebis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazole-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonylethyl)-2'-hydroxyphenyl]-2H-benzotriazole with polyethylene glycol 300; $[R-CH_2CH_2-COO(CH_2)_3]_2^-$, where R = 3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-ylphenyl.

2.2.2-Hydroxybenzophenones, for example the 4-hydroxy, 4-methoxy, 4-octyloxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy and 2'-hydroxy-4,4'-dimethoxy derivatives.

2.3. Esters of substituted and unsubstituted benzoic acids, as for example 4-tertbutylphenyl salicylate, phenyl salicylate, octylphenyl salicylate, dibenzoyl resorcinol, bis(4-tert-butylbenzoyl) resorcinol, benzoyl resorcinol, 2,4-di-tertbutylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, hexadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, octadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-methyl-4,6-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate.

2.4. Acrylates, for example ethyl α -cyano- β,β -diphenylacrylate, isooctyl α -cyano- β,β -diphenylacrylate, methyl α -carbomethoxycinnamate, methyl α -cyano- β -methyl-p-methoxycinnamate, butyl α -cyano- β -methyl-p-methoxy-cinnamate, methyl α -carbomethoxy-p-methoxycinnamate and N-(β -carbomethoxy- β -cyanovinyl)-2-methylindoline.

2.5. Nickel compounds, for example nickel complexes of 2,2'-thio-bis-[4-(1,1,3,3-tetramethylbutyl)phenol], such as the 1:1 or 1:2 complex, with or without additional ligands such as n-butylamine, triethanolamine or N-cyclohexyldiethanolamine, nickel dibutyldithiocarbamate, nickel salts of the monoalkyl esters, e.g. the methyl or ethyl ester, of 4-hydroxy-3,5-di-tert-butylbenzylphosphonic acid, nickel complexes of ketoximes, e.g. of 2-hydroxy-4-methylphenyl undecylketoxime, nickel complexes of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands.

2.6. Sterically hindered amines, for example bis(2,2,6,6-tetramethyl-piperidyl)sebacate, bis(2,2,6,6-tetramethyl-piperidyl)succinate, bis(1,2,2,6,6-pentamethylpiperidyl)sebacate, bis(1,2,2,6,6-pentamethylpiperidyl)n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, the condensate of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, the condensate of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-1,3,5-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl) nitritotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl)-1,2,3,4-butane-tetracarboxylate, 1,1'-(1,2-ethanediy)bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl)-2-n-butyl-2-(2-hydroxy-3,5-di-tert-butylbenzyl)malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decan-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)succinate, the condensate of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-morpholino-2,6-dichloro-1,3,5-triazine, the condensate of 2-chloro-4,6-bis(4-n-butylamino-2,2,6,6-tetramethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)-ethane, the condensate of 2-chloro-4,6-di-(4-n-butylamino-1,2,2,6,6-pentamethylpiperidyl)-1,3,5-triazine and 1,2-bis-(3-aminopropylamino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidin-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione.

2.7. Oxamides, for example 4,4'-dioctyloxyoxanilide, 2,2'-diethoxyoxanilide, 2,2'-dioctyloxy-5,5'-di-tert-butoxanilide, 2,2'-didodecyloxy-5,5'-di-tert-butoxanilide, 2-ethoxy-2'-ethyloxanilide, N,N'-bis(3-dimethylaminopropyl)oxamide, 2-ethoxy-5-tert-butyl-2'-ethoxanilide and its mixture with 2-ethoxy-2'-ethyl-5,4'-di-tert-butoxanilide and mixtures of ortho- and para-methoxy-disubstituted oxanilides and mixtures of o- and p-ethoxy-disubstituted oxanilides.

2.8. 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxy-propoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxy-propyloxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine.

3. Metal deactivators, for example N,N'-diphenyloxamide, N-salicylal-N'-salicyloyl hydrazine, N,N'-bis(salicyloyl) hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl) hydrazine, 3-salicyloylamino-1,2,4-triazole, bis(benzylidene)oxalyl dihydrazide, oxanilide, isophthaloyl dihydrazide, sebacoyl bisphenylhydrazide, N,N'-diacetyl adipoyl dihydrazide, N,N'-bis(salicyloyl)oxalyl dihydrazide, N,N'-bis(salicyloyl)thiopropionyl dihydrazide.

4. Phosphites and phosphonites, for example triphenyl phosphite, diphenyl alkyl phosphites, phenyl dialkyl phosphites, tris(nonylphenyl) phosphite, triauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butylphenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl) pentaerythritol diphosphite, bis(2,6-di-tert-butyl-4-methylphenyl)-pentaerythritol diphosphite, diisodecylpentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl)pentaerythritol diphosphite, bis(2,4,6-tris(tert-butylphenyl)pentaerythritol diphosphite, tristearyl sorbitol triphosphite, tetrakis(2,4-di-tert-butylphenyl) 4,4'-biphenylene diphosphonite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-12H-dibenz[d,g]-1,3,2-dioxaphosphocin, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenz[d,g]-1,3,2-dioxaphosphocin, bis(2,4-di-tert-butyl-6-methylphenyl)methylphosphite, bis(2,4-di-tert-butyl-6-methylphenyl)ethylphosphite.

5. Hydroxylamines, for example dibenzylhydroxylamine, dioctylhydroxylamine, didodecylhydroxylamine, ditetradecylhydroxylamine, dihexadecylhydroxylamine, dioctadecylhydroxylamine, 1-hydroxy-2,2,6,6-tetramethyl-4-piperidyl benzoate or bis(1-hydroxy-2,2,6,6-tetramethyl-4-piperidyl)sebacate.

6. Peroxide scavengers, for example esters of β -thiodipropionic acid, for example the lauryl, stearyl, myristyl or tridecyl esters, mercaptobenzimidazole or the zinc salt of 2-mercaptobenzimidazole, zinc dibutyl-dithiocarbamate, dioctadecyl disulfide, pentaerythritol tetrakis(β -dodecylmercapto)propionate.

7. Polyamide stabilisers, for example, copper salts in combination with iodides and/or phosphorus compounds and salts of divalent manganese.

8. Basic co-stabilisers, for example, melamine, polyvinylpyrrolidone, dicyandiamide, triallyl cyanurate, urea derivatives, hydrazine derivatives, amines, polyamides, polyurethanes, alkali metal salts and alkaline earth metal salts of higher fatty acids for example calcium stearate, zinc stearate, magnesium behenate, magnesium stearate, sodium ricinoleate and potassium palmitate, antimony pyrocatecholate or tin pyrocatecholate.

9. Nucleating agents, for example, 4-tert-butylbenzoic acid, adipic acid, diphenylacetic acid.

10. Fillers and reinforcing agents, for example, calcium carbonate, silicates, glass fibres, asbestos, talc, kaolin, mica, barium sulfate, metal oxides and hydroxides, carbon black, graphite.

11. Other additives, for example, plasticisers, lubricants, emulsifiers, pigments, optical brighteners, flameproofing agents, antistatic agents and blowing agents.

12. Benzofuranones and indolinones, for example those disclosed in US-A-4 325 863, US-A-4 338 244, US-A-5 175 312, US-A-5 216 052, US-A-5 252 643, DE-A-4 316 611, DE-A-4 316 622, DE-A-4 316 876, EP-A-0 589 839 or EP-A-0 591 102 or 3-[4-(2-acetoxyethoxy)phenyl]-5,7-di-tert-butyl-benzofuran-2-one, 5,7-di-tert-butyl-3-[4-(2-stearoyloxyethoxy)phenyl]benzofuran-2-one, 3,3'-bis[5,7-di-tert-butyl-3-[4-(2-hydroxyethoxy)phenyl]benzofuran-2-one], 5,7-di-tert-butyl-3-(4-ethoxyphenyl)benzofuran-2-one, 3-(4-acetoxy-3,5-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(3,5-dimethyl-4-pivaloyloxyphenyl)-5,7-di-tert-butyl-benzofuran-2-one.

The compounds of the formula (I) can also be used as stabilizers, especially as light stabilizers, for almost all materials known in the art of photographic reproduction and other reproduction techniques as e.g. described in Research Disclosure 1990, 31429 (pages 474 to 480).

Several examples of the preparation and use of the compounds of the formula (I) are reported for more detailed illustration of the present invention; these examples are given solely for illustrative purposes and do not imply any restriction.

Example 1:

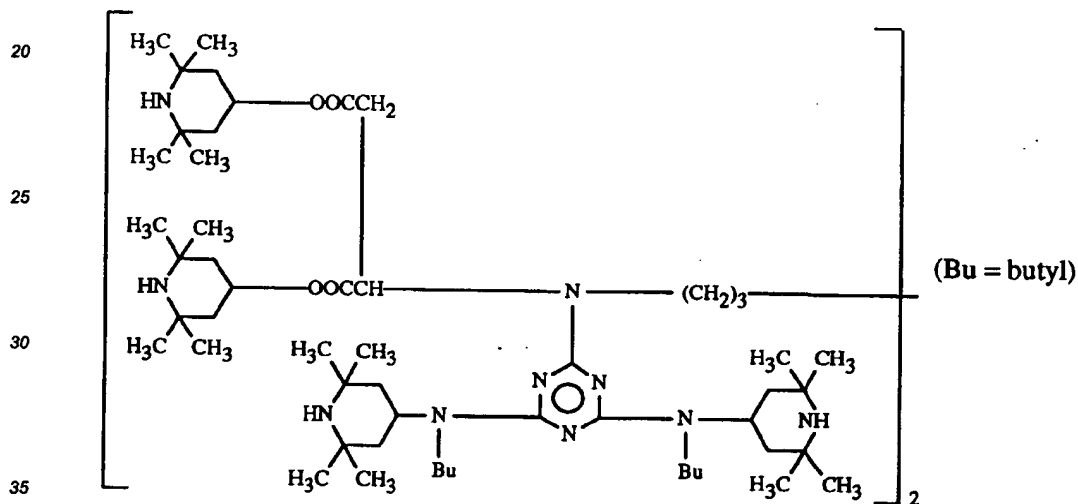
a) Preparation of tetrakis(2,2,6,6-tetramethyl-4-piperidyl) N,N'-hexamethylenediaspartate.

63.1 g (0.16 mol) of bis(2,2,6,6-tetramethyl-4-piperidyl) maleate and 9.3 g (0.08 mol) of hexamethylenediamine in 120 ml of dimethylformamide are heated for 16 hours at 90°C and then allowed to cool slowly to ambient temperature. The precipitate which has formed is separated off by filtration, washed with a little dimethylformamide and then with acetone and finally dried in vacuo. The product obtained melts at 124-126°C.

Analysis for $C_{50}H_{92}N_8O_8$

calculated:	C=66.34%;	H=10.24%;	N=9.28%
found:	C=66.17%;	H=10.24%	N=9.30%

b) Preparation of the product of the formula



31.7 g (0.035 mol) of tetrakis(2,2,6,6-tetramethyl-4-piperidyl) N,N'-hexamethylenediaspartate are added in the course of 45 minutes to a solution of 12.9 g (0.07 mol) of cyanuric chloride in 130 ml of dichloromethane, maintaining the temperature at -10°C. After the end of the addition, the mixture is stirred for 30 minutes at -10°C, and the temperature is then allowed to rise up to 0°C and, at this temperature, a solution of 2.8 g (0.07 mol) of NaOH in 15 ml of water is added slowly, the mixture is stirred for 30 minutes at 20°C and the aqueous phase is separated off.

150 ml of mesitylene and 41.6 g (0.196 mol) of 4-butylamino-2,2,6,6-tetramethylpiperidine are added, the dichloromethane is distilled off and the mixture is heated for 3 hours at 140°C.

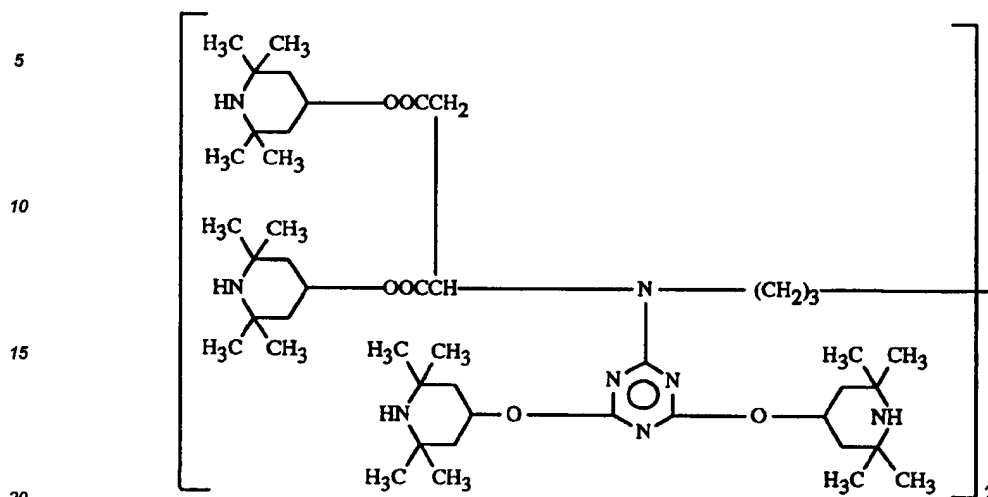
38.7 g (0.28 mol) of ground K_2CO_3 are added and the mixture is heated under reflux for 12 hours, the water of reaction being separated off azeotropically.

After cooling to ambient temperature, the reaction mixture is filtered in order to separate off the inorganic salts, and the solvent and the excess of 4-butylamino-2,2,6,6-tetramethylpiperidine are removed in vacuo.

The product obtained melts at 96-99°C.

Analysis for $C_{108}H_{198}N_{20}O_8$

calculated:	C=68.10%;	H=10.48%;	N=14.71%
found:	C=67.89%;	H=10.40%;	N=14.56%

Example 2: Preparation of the product of the formula

21.7 g (0.024 mol) of tetrakis(2,2,6,6-tetramethyl-4-piperidyl) N,N'-hexamethylenediaspartate and 20.5 g (0.048 mol) of 2-chloro-4,6-bis(2,2,6,6-tetramethyl-4-piperidyloxy)-1,3,5-triazine in 100 ml of t-amyl alcohol are heated under reflux for 12 hours. 13.3 g (0.096 mol) of ground K_2CO_3 are added and the mixture is heated under reflux for 8 hours.

The solvent is evaporated in vacuo and the residue is taken up in 150 ml of dichloromethane and 50 ml of water. The aqueous phase is separated off and the organic phase is washed with water, dried over anhydrous Na_2SO_4 and evaporated in vacuo.

The product obtained melts at 95-98°C.

Analysis for $C_{92}H_{182}N_{18}O_{12}$			
calculated:	C=65.60%;	H=9.60%;	N=13.30%
found:	C=65.16%;	H=9.69%	N=13.25%

calculated:	C=65.60%;	H=9.60%;	N=13.30%
found:	C=65.16%;	H=9.69%	N=13.25%

Example 3

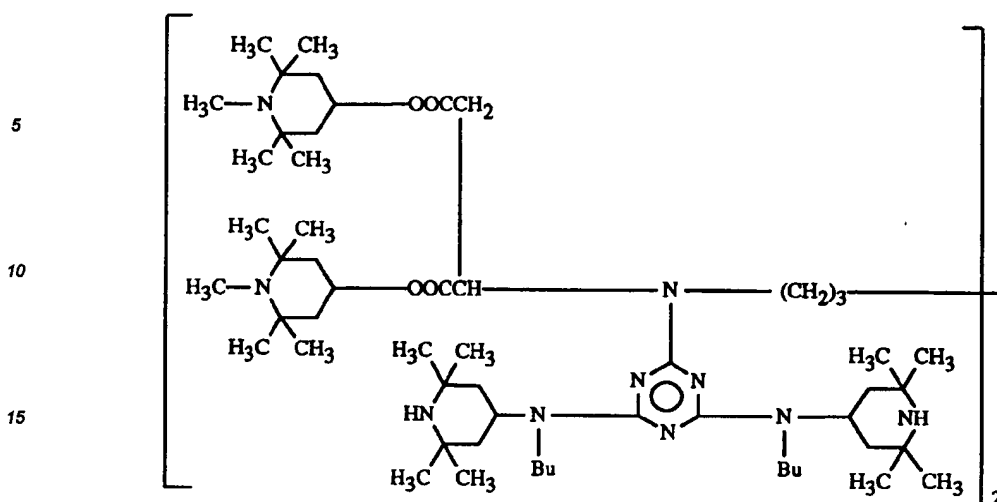
a) The tetrakis(1,2,2,6,6-pentamethyl-4-piperidyl) N,N'-hexamethylenediaspartate is prepared as described in Example 1a by reacting 42.3 g (0.1 mol) of bis(1,2,2,6,6-pentamethyl-4-piperidyl) maleate with 5.8 g (0.05 mol) of hexamethylenediamine.

The product obtained is a dense oil.

Analysis for $C_{54}H_{100}N_8O_8$			
calculated:	C=67.46%;	H=10.48%;	N=8.74%
found:	C=67.44%;	H=10.47%	N=8.67%

calculated:	C=67.46%;	H=10.48%;	N=8.74%
found:	C=67.44%;	H=10.47%	N=8.67%

b) The product of the formula



20 is prepared as described in Example 1b by reacting 38.5 g (0.04 mol) of tetrakis(1,2,2,6,6-pentamethyl-4-piperidyl) N,N'-hexamethylenediaspartate with 14.8 g (0.08 mol) of cyanuric chloride and 47.6 g (0.224 mol) of 4-butylamino-2,2,6,6-tetramethylpiperidine.

The product obtained melts at 93-95°C.

25

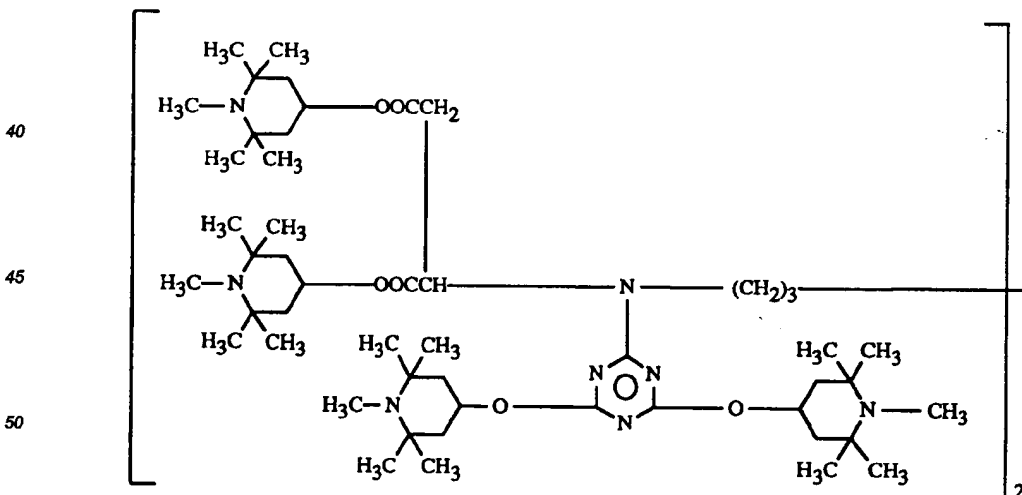
Analysis for $C_{112}H_{206}N_{20}O_8$			
calculated:	C=68.60%;	H=10.59%;	N=14.28%
found:	C=68.60%;	H=10.55%	N=14.21%

30

Example 4:

The product of the formula

35



55 is prepared as described in Example 2 by reacting 19.2 g (0.02 mol) of tetrakis(1,2,2,6,6-pentamethyl-4-piperidyl) N,N'-hexamethylenediaspartate with 18.2 g (0.04 mol) of 2-chloro-4,6-bis(1,2,2,6,6-pentamethyl-4-piperidyloxy)-1,3,5-triazine.

The product obtained melts at 109-112°C.

Analysis for $C_{100}H_{178}N_{16}O_{12}$

calculated:	C=66.85%;	H=9.99%;	N=12.47%
found:	C=66.76%;	H=9.93%	N=12.43%

Example 5:

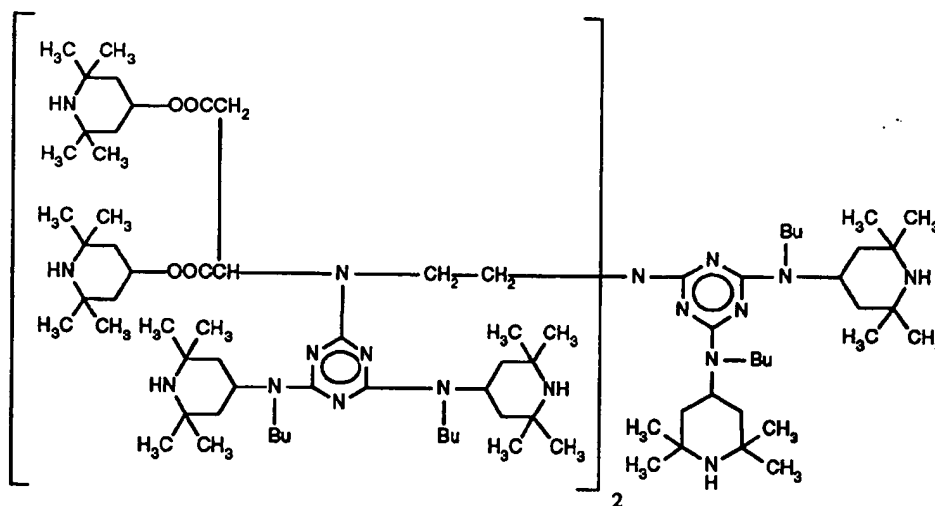
a) The tetrakis(2,2,6,6-tetramethyl-4-piperidyl) N,N'-(iminodiethylene)diaspartate is prepared as described in Example 1a by reacting 94.7 g (0.24 mol) of bis(2,2,6,6-tetramethyl-4-piperidyl) maleate with 12.4 g (0.12 mol) of diethylenetriamine.

The product obtained is a dense oil.

Analysis for $C_{48}H_{89}N_7O_8$

calculated:	C=64.61%;	H=10.05%;	N=10.99%
found:	C=64.02%;	H=9.90%	N=10.91%

b) The product of the formula



is prepared as described in Example 1b by reacting 26.8 g (0.03 mol) of tetrakis(2,2,6,6-tetramethyl-4-piperidyl) N,N'-(iminodiethylene)diaspartate with 16.6 g (0.09 mol) of cyanuric chloride and 53.5 g (0.252 mol) of 4-butylamino-2,2,6,6-tetramethylpiperidine.

The product obtained melts at 111-113°C.

Analysis for $C_{135}H_{248}N_{28}O_8$

calculated:	C=67.80%;	H=10.45%;	N=16.40%
found:	C=66.90%;	H=10.41%	N=16.30%

Example 6:

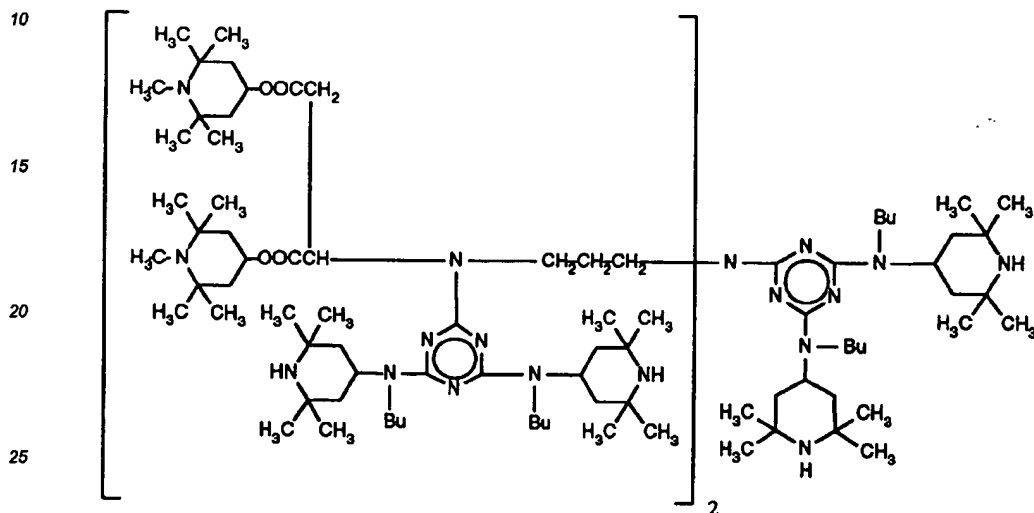
a) The tetrakis(1,2,2,6,6-pentamethyl-4-piperidyl) N,N'-[iminobis(trimethylene)]diaspartate is prepared as described in Example 1a by reacting 67.6 g (0.16 mol) of bis(1,2,2,6,6-pentamethyl-4-piperidyl) maleate with 10.5 g (0.08 mol) of bis(3-aminopropyl)amine.

The product obtained is a dense oil.

Analysis for $C_{64}H_{101}N_7O_8$

calculated:	C=66.42%;	H=10.43%;	N=10.04%
found:	C=65.89%;	H=10.40%	N=9.98%

b) The product of the formula



is prepared as described in Example 1b by reacting 39.1 g (0.04 mol) of tetrakis(1,2,2,6,6-pentamethyl-4-piperidyl) N,N'-[iminobis(trimethylene)]diaspartate with 22.1 g (0.12 mol) of cyanuric chloride and 71.4 g (0.336 mol) of 4-butylamino-2,2,6,6-tetramethylpiperidine.

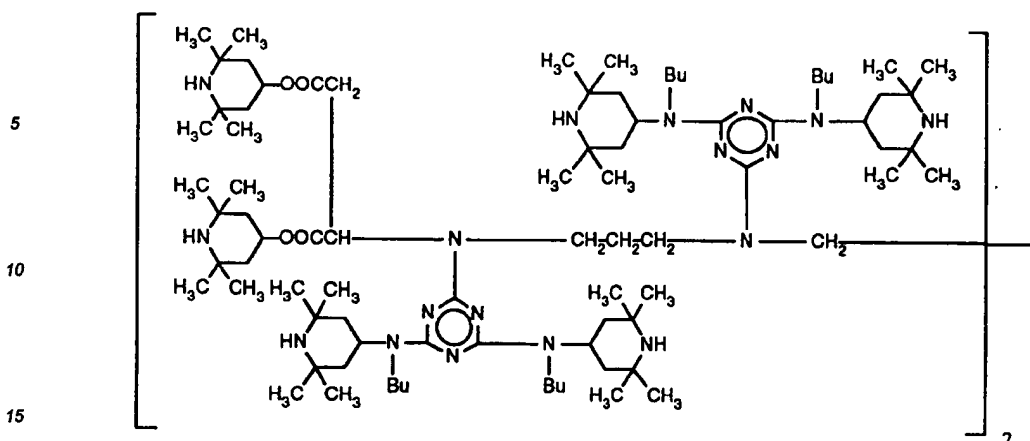
The product obtained melts at 118-121°C.

Analysis for $C_{141}H_{260}N_{28}O_8$

calculated:	C=68.40%;	H=10.58%;	N=15.84%
found:	C=68.49%;	H=10.46%	N=15.71%

Example 7:

Preparation of the product of the formula



23.1 g (0.05 mol) of tetramethyl N,N'-[ethylenebis(iminotrimethylene)]diaspartate are added in the course of 45 minutes to a mixture, maintained at -10°C, of 36.9 g (0.2 mol) of cyanuric chloride and 46.2 g (0.27 mol) of 2,2,6,6-tetramethyl-4-piperidinol in 500 ml of xylene. After the end of the addition, the mixture is stirred for 30 minutes at -10°C and for 2 hours at 20°C.

85 g (0.4 mol) of 4-butylamino-2,2,6,6-tetramethylpiperidine are added and the mixture is heated for 3 hours at 90°C. 55.3 g (0.4 mol) of ground K₂CO₃ are added and the mixture is heated under reflux for 12 hours.

After cooling to 20°C, 11.9 g (0.22 mol) of sodium methoxide are added and the mixture is stirred for 15 minutes and then heated under reflux for 12 hours, with the methanol released being separated off by distillation.

After cooling to ambient temperature, the reaction mixture is washed with water up to complete removal of chlorine ions and is finally dried by heating to 200°C at 6 mbar, in order to separate off the excess 2,2,6,6-tetramethyl-4-piperidinol.

The product obtained melts at 126-129°C.

Analysis for C ₁₆₈ H ₃₁₀ N ₃₈ O ₈			
calculated:	C=68.11%;	H=10.55%;	N=17.02%
found:	C=67.90%;	H=10.42%	N=17.00%

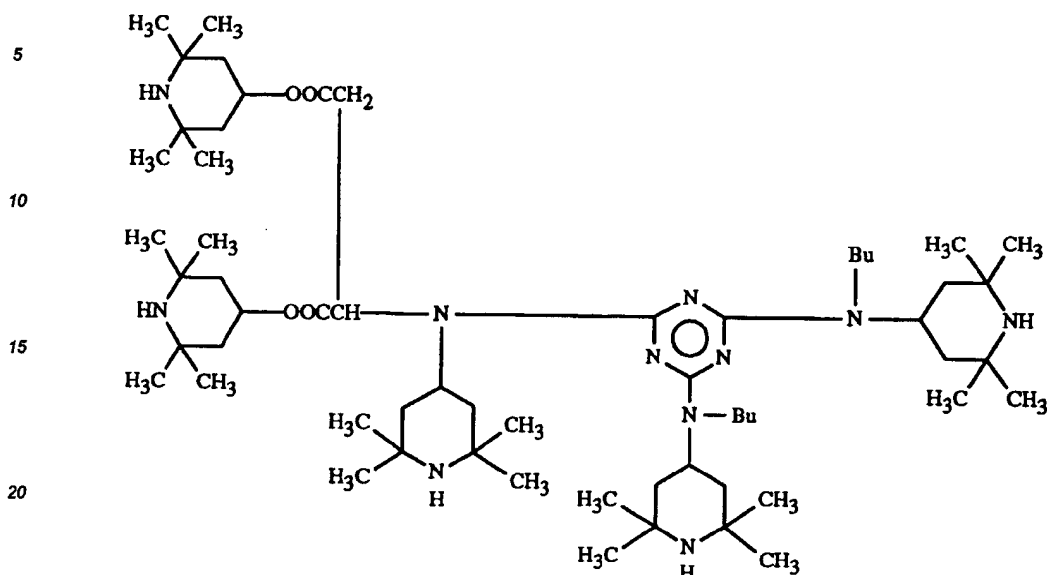
Example 8:

a) Preparation of diethyl N-(2,2,6,6-tetramethyl-4-piperidyl)aspartate.

78.1 g (0.5 mol) of 4-amino-2,2,6,6-tetramethylpiperidine and 86.1 g (0.5 mol) of diethyl maleate in 200 ml of tetrahydrofuran are heated under reflux for 6 hours. The solvent is evaporated in vacuo and the product is separated off by distillation: boiling point 116-118°C/0.5 mbar.

Analysis for C ₁₇ H ₃₂ N ₂ O ₄			
calculated:	C=62.17%;	H=9.82%;	N=8.53%
found:	C=62.01%;	H=9.78%	N=8.49%

b) Preparation of the product of the formula



25 A solution of 32.8 g (0.1 mol) of diethyl N-(2,2,6,6-tetramethyl-4-piperidyl)aspartate in 100 ml of xylene is added slowly to a solution of 18.4 g (0.1 mol) of cyanuric chloride in 100 ml of xylene, maintaining the temperature at 0°C. The mixture is stirred for 3 hours at ambient temperature, a solution of 13.8 g (0.1 mol) of K₂CO₃ in 50 ml of water is then added slowly, maintaining the temperature at 10°C, the mixture is stirred for 1 hour at ambient temperature and the aqueous phase is separated off.

30 42.5 g (0.2 mol) of 4-butylamino-2,2,6,6-tetramethylpiperidine are added and the mixture is heated under reflux for 3 hours, the water being separated off azeotropically.

The mixture is cooled to 60°C, 41.5 g (0.3 mol) of ground K₂CO₃ are added, and the mixture is again heated under reflux for 8 hours, with azeotropic removal of the water of reaction. The mixture is then cooled to 50°C and filtered in order to separate off the inorganic salts.

35 37.7 g (0.24 mol) of 2,2,6,6-tetramethyl-4-piperidinol and 0.8 ml of Ti(IV) isopropoxide are added to the solution thus obtained and the mixture is heated under reflux for 8 hours, removing the ethanol formed during the reaction. After cooling to ambient temperature, the solution is washed several times with water in order to remove the excess 2,2,6,6-tetramethyl-4-piperidinol and evaporated in vacuo. The oily residue obtained crystallizes slowly from hexane: melting point 79-81°C.

40

Analysis for C ₈₀ H ₁₁₁ N ₁₁ O ₄			
calculated:	C=68.59%;	H=10.65%;	N=14.66%
found:	C=68.19%;	H=10.58%	N=14.66%

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Example 9:

50 a) Preparation of bis(2,2,6,6-tetramethyl-4-piperidyl) N-butylaspartate.

43.5 g (0.2 mol) of dimethyl N-butylaspartate, 78.6 g (0.5 mol) of 2,2,6,6-tetramethyl-4-piperidinol and 0.5 ml of Ti(IV) isopropoxide in 200 ml of xylene are heated under reflux for 10 hours with removal of the methanol formed during the reaction.

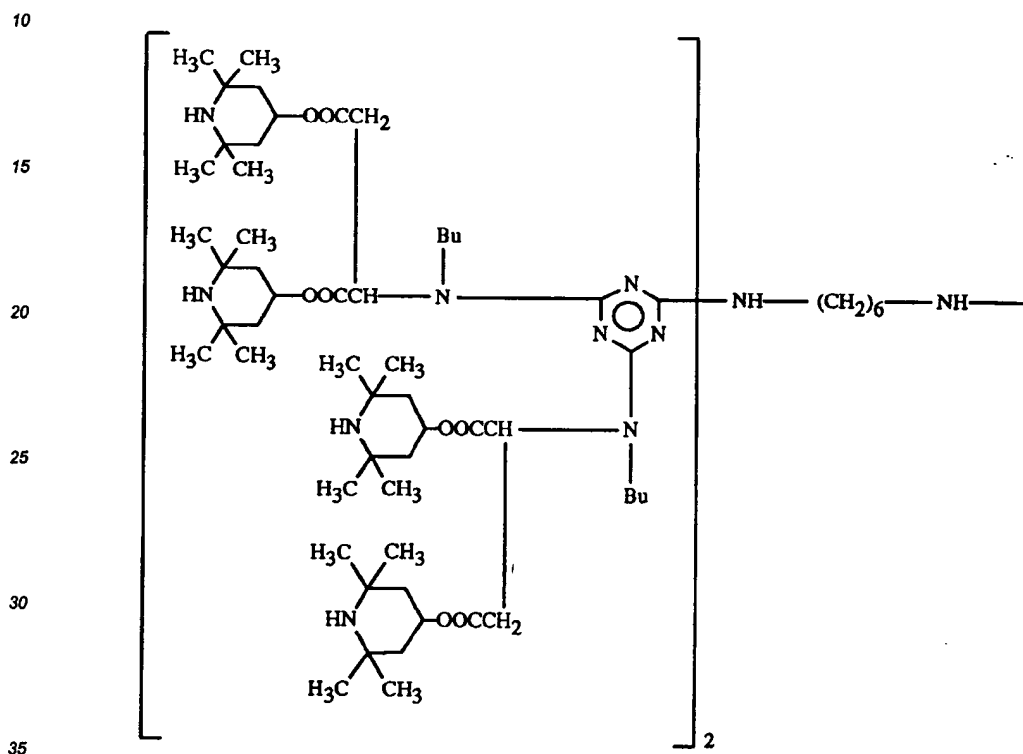
55 After cooling to ambient temperature, the mixture is washed several times with water in order to remove the excess 2,2,6,6-tetramethyl-4-piperidinol and evaporated by heating up to 100°C at 2 mbar.

The product is obtained as a oily residue.

Analysis for $C_{28}H_{49}N_3O_4$

calculated:	C=66.77%;	H=10.56%;	N=8.98%
found:	C=66.63%;	H=10.52%	N=8.94%

b) Preparation of the product of the formula



A solution of 56.1 g (0.12 mol) of bis(2,2,6,6-tetramethyl-4-piperidyl) N-butylaspartate in 50 ml of xylene is added slowly to a solution of 22.1 g (0.12 mol) of cyanuric chloride in 250 ml of xylene, maintaining the temperature at 20°C. After the end of the addition, the mixture is stirred for 1 hour at 20°C, 20 g (0.145 mol) of ground K_2CO_3 are added and the mixture is stirred for a further 2 hours at 20°C.

After heating to 80°C, a solution of 56.1 g (0.12 mol) of bis(2,2,6,6-tetramethyl-4-piperidyl) N-butylaspartate in 50 ml of xylene is added slowly.

The mixture is heated for 2 hours at 110°C, 20 g (0.145 mol) of ground K_2CO_3 are added and the mixture is heated again at 110°C for 5 hours.

After cooling to 80°C, 7 g (0.06 mol) of hexamethylenediamine and 29 g (0.21 mol) of ground K_2CO_3 are added and the mixture is heated under reflux for 8 hours with the water of reaction being distilled off azeotropically.

After cooling to ambient temperature, the mixture is filtered in order to separate off the inorganic salts, and the solvent is evaporated in vacuo.

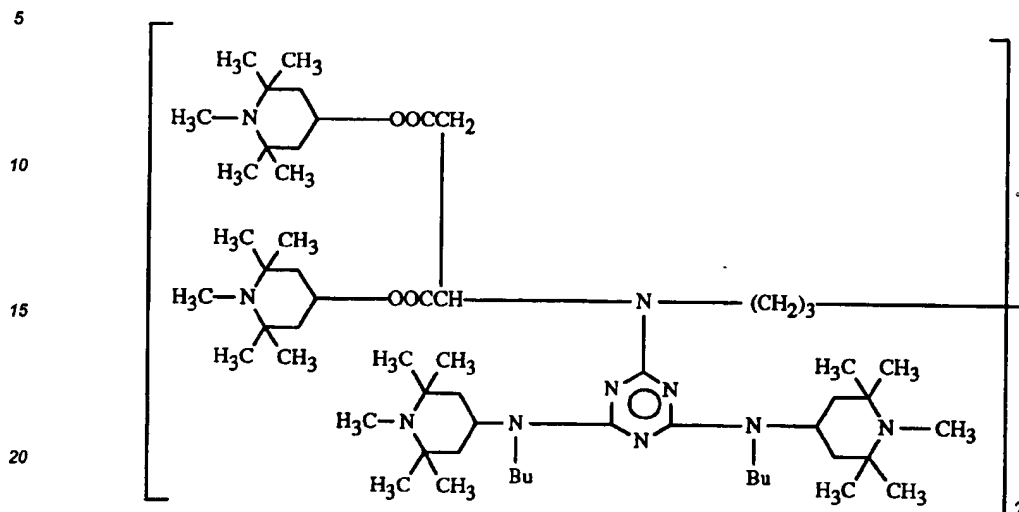
The product obtained melts at 77-80°C.

Analysis for $C_{118}H_{206}N_{20}O_{16}$

calculated:	C=65.20%;	H=9.72%;	N=13.11%
found:	C=64.50%;	H=9.61%	N=12.96%

Example 10:

Preparation of the product of the formula



25 A solution containing 4.3 g (0.144 mol) of formaldehyde (free of methanol) and 6.6 g (0.144 mol) of formic acid in 50 ml of water is added in the course of 2 hours to a solution, heated under reflux, of 28.6 g (0.015 mol) of the product from Example 1 in 150 ml of toluene, with simultaneous azeotropic removal of the water added and of the water of reaction.

After cooling to ambient temperature, a solution of 5.8 g of NaOH in 50 ml of water is added, the mixture is stirred for 15 minutes and the aqueous phase is separated off.

30 The organic phase is washed with water and evaporated in vacuo.

The product obtained melts at 119-121°C.

Analysis for $\text{C}_{116}\text{H}_{214}\text{N}_{20}\text{O}_8$

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calculated: C = 69.07%; H = 10.69%; N = 13.89%

found: C = 68.56%; H = 10.53%; N = 13.69%

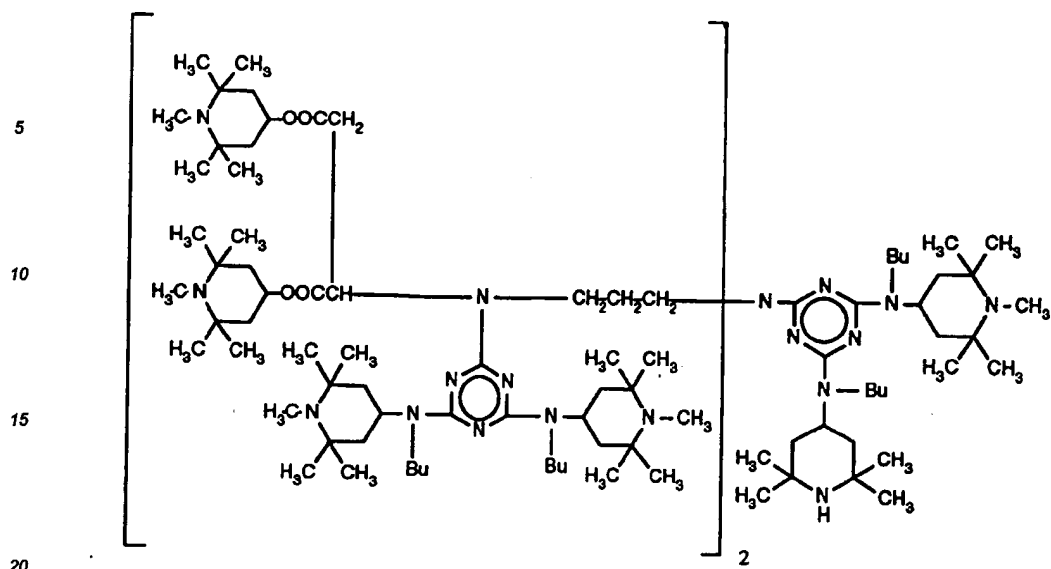
40 **Example 11:**

The product of the formula

45

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55



is prepared as described in Example 10 by reacting 24.8 g (0.01 mol) of the product from Example 6 with 3.6 g (0.12 mol) of formaldehyde and 5.5 g (0.12 mol) of formic acid.

The product obtained melts at 133-135°C.

25

Analysis for $C_{147}H_{272}N_{28}O_8$

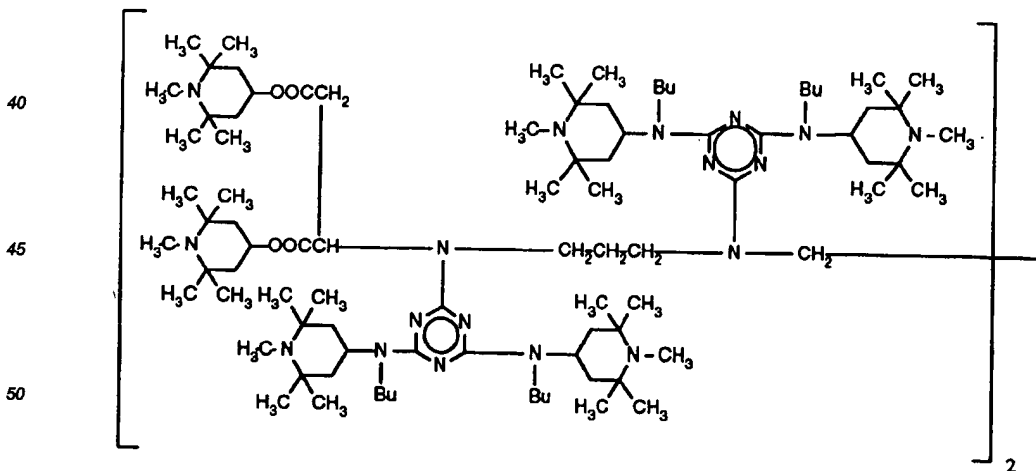
calculated:	C=68.97%;	H=10.71%;	N=15.32%
found:	C=68.41%;	H=10.54%;	N=15.30%

30

Example 12:

35

The product of the formula



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is prepared as described in Example 10 by reacting 29.6 g (0.01 mol) of the product from Example 7 with 4.3 g (0.144 mol) of formaldehyde and 6.6 g (0.144 mol) of formic acid.

The product obtained melts at 141-144°C.

Analysis for $C_{180}H_{334}N_{36}O_8$			
calculated:	C=69.05%;	H=10.75%;	N=16.11%
found:	C=68.81%;	H=10.58%	N=15.99%

Example 13: (Light-stabilizing action in polypropylene fibres)

2.5 g of each of the products indicated in Table 1, 1 g of tris(2,4-di-*t*-butylphenyl) phosphite, 0.5 g of calcium monoethyl 3,5-di-*t*-butyl-4-hydroxybenzylphosphonate, 1 g of calcium stearate and 2.5 g of titanium dioxide are mixed in a turbo mixer with 1000 g of a polypropylene powder of melt index = 12 g/10 minutes (measured 230°C and 2.16 kg).

The mixtures are extruded at 230-245°C to give polymer granules which are then converted into fibres, using a pilot-type apparatus (Leonard-Sumirago (VA) Italy) operating under the following conditions:

extruder temperature : 230-245°C
 head temperature : 255-260°C
 stretch ratio : 1:3.5
 count : 11 dtex per filament

The fibres thus prepared are exposed, mounted on a white card, in a model 65 WR Weather-O-Meter (ASTM D2565-85) with a black panel temperature of 63°C.

The residual tenacity is measured on samples taken after various times of exposure to light by means of a constant-speed tensometer, and the exposure time in hours (T_{50}) needed to halve the initial tenacity is then calculated.

The fibres prepared under the same conditions as indicated above, but without addition of the stabilizers according to the invention, are exposed for comparison. The results obtained are shown in Table 1. The longer the time the better is the stabilizing effect.

TABLE 1

Stabilizer	T_{50} (hours)
None	260
Product from Example 1	2900
Product from Example 3	2630
Product from Example 4	2900
Product from Example 5	2600
Product from Example 6	2600
Product from Example 11	2600

Example 14: (Light-stabilizing action in polypropylene tapes)

1 g of each of the compounds indicated in Table 2, 1 g of tris(2,4-di-*tert*-butylphenyl)-phosphite, 0.5 g of pentaerythritol tetrakis[3-(3,5-di-*tert*-butyl-4-hydroxy-phenyl)propionate] and 1 g of calcium stearate are mixed in a turbo mixer with 1000 g of polypropylene powder having a melt index = 2 g/10 min. (measured at 230°C and 2.16 kg). The mixtures are extruded at 200-220°C to give polymer granules which are subsequently converted to stretched tapes of 50 µm thickness and 2.5 mm width, using a semi-industrial type of apparatus (Leonard-Sumirago (VA), Italy) and working under the following conditions:

extruder temperature : 210-230°C
 head temperature : 240-260°C
 stretch ratio : 1:6

The tapes thus prepared are mounted on white card and exposed in a Weather-O-Meter 65 WR (ASTM D 2565-85) with a black panel temperature of 63°C. The residual tenacity is measured, by means of a constant

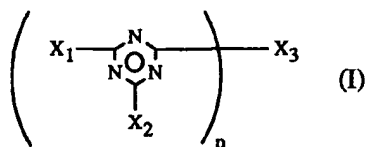
velocity tensometer, on samples taken after various light exposure times; from this, the exposure time (in hours) required to halve the initial tenacity (T_{50}) is measured. By way of comparison, tapes prepared under the same conditions as indicated above, but without the addition of the stabilizers of the present invention, are exposed. The results obtained are shown in Table 2. The longer the time the better is the stabilizing effect.

TABLE 2

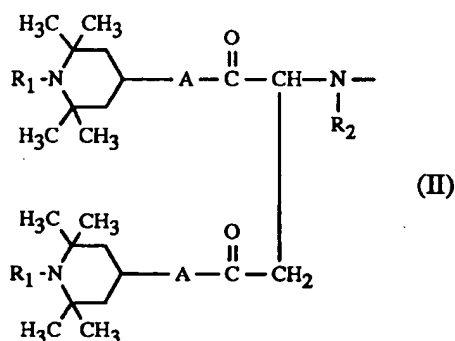
Stabilizer	T_{50} (hours)
None	530
Product from Example 2	3590

Claims

1. A compound of the formula (I)

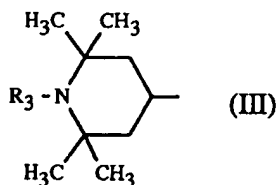


in which X_1 and X_2 which can be identical or different are a group of the formula (II)



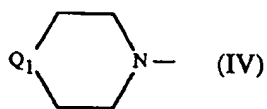
in which

R_1 is hydrogen, C_1 - C_8 alkyl, O, OH, CH_2CN , C_1 - C_{18} alkoxy, C_5 - C_{12} cycloalkoxy, C_3 - C_8 -alkenyl, C_7 - C_9 phenylalkyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C_1 - C_4 alkyl; or aliphatic C_1 - C_8 acyl, R_2 is hydrogen, C_1 - C_{18} alkyl, C_5 - C_{12} cycloalkyl unsubstituted or mono-, di- or tri-substituted by C_1 - C_4 alkyl; C_7 - C_9 phenylalkyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C_1 - C_4 alkyl; tetrahydrofurfuryl or a group of the formula (III)

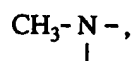


where R_3 is as defined for R_1 or C_2 - C_4 alkyl substituted in the 2-, 3- or 4-position by C_1 - C_8 alkoxy, by di(C_1 -

C₄alkyl)amino or by a group of the formula (IV)



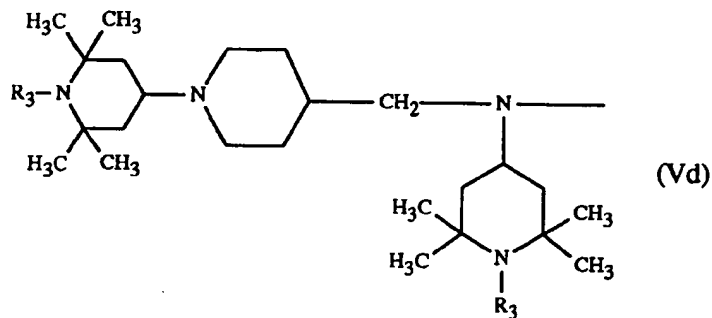
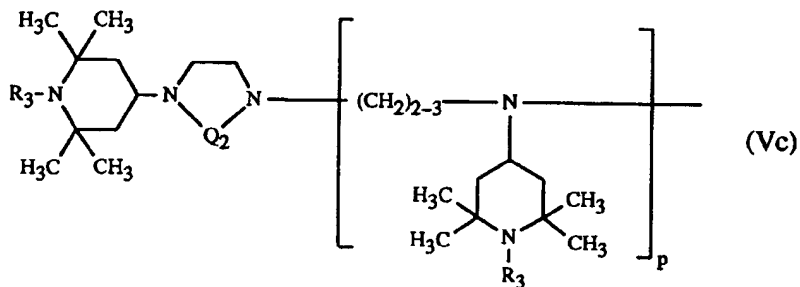
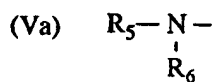
where Q₁ is a direct bond, -O-, -CH₂-, -CH₂CH₂- or

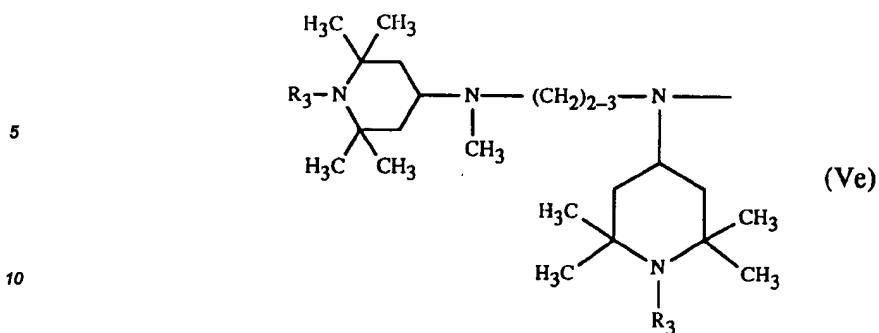


and A is -O- or



with R₄ being hydrogen or C₁-C₁₂alkyl, or X₁ and X₂ are a group of the formula (IV) or one of the groups of the formulae (Va)-(Ve)





in which

R_3 is as defined above,

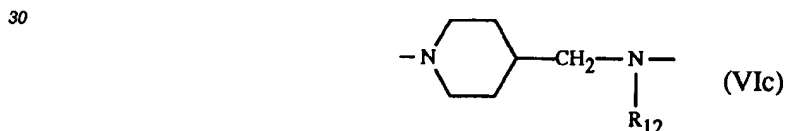
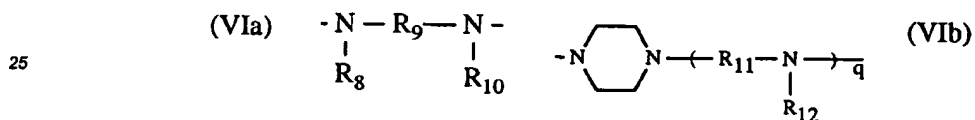
R_5 , R_6 and R_7 which can be identical or different are as defined for R_2 , or R_7 is also C_3 - C_{18} alkenyl or phenyl unsubstituted or mono-, di- or tri-substituted by C_1 - C_4 alkyl or C_1 - C_4 alkoxy;

Q_2 is $-CO-$, $-CH_2CH_2-$, $-COCO-$, $-CH_2CO-$ or $-COCH_2CO-$ and

p is zero or 1,

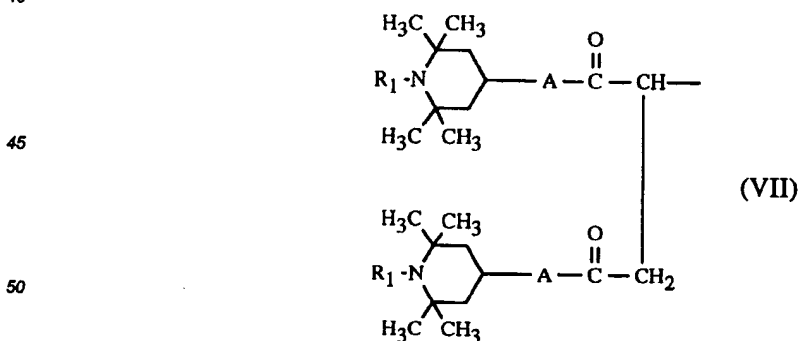
n is 1, 2, 3 or 4 and,

if n is 1, X_3 is as defined for X_1 and X_2 , and, if n is 2, X_3 is one of the formulae (VIa)-(VIc)



in which

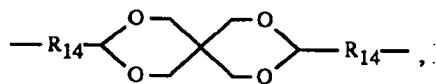
R_8 , R_{10} and R_{12} which can be identical or different are as defined for R_2 , or R_8 and R_{10} are also a group of the formula (VII)



55 with R_1 and A as defined above, R_9 is C_2 - C_{12} alkylene, C_5 - C_7 cycloalkylene, C_5 - C_7 cycloalkylenedi(C_1 - C_4 alkylene), C_1 - C_4 alkylenedi(C_5 - C_7 cycloalkylene), phenylenedi(C_1 - C_4 alkylene) or C_4 - C_{12} alkylene interrupted by a 1,4-piperazinediyl group or by 1, 2 or 3 oxygen atoms or by 1 or 2



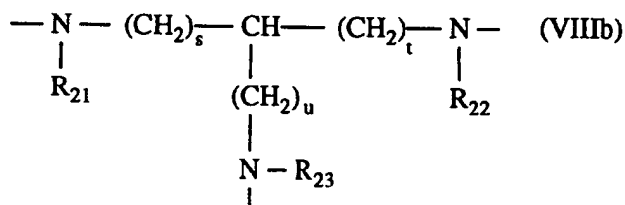
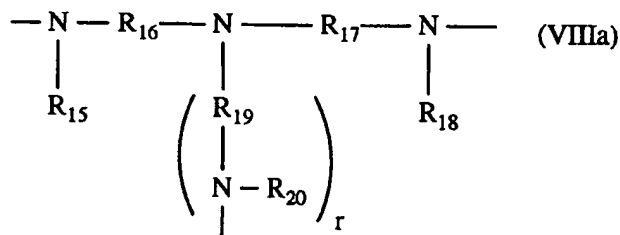
groups, where R_{13} is as defined for R_2 or is aliphatic C_1 - C_{12} acyl or $(C_1$ - C_{12} alkoxy)carbonyl, or R_9 is also a group



R_{11} and R_{14} are C_2 - C_6 alkylene and

q is zero or 1, and

if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb)



in which

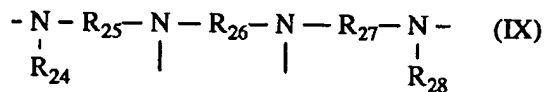
R_{15} , R_{18} , R_{20} , R_{21} , R_{22} and R_{23} which can be identical or different are as defined above for R_8 and R_{10} ,

R_{16} , R_{17} and R_{19} which can be identical or different are C_2 - C_6 alkylene,

r and u are zero or 1, and

s and t which can be identical or different are integers from 2 to 6, and,

if n is 4, X_3 is a group of the formula (IX)



in which

R_{24} and R_{28} which can be identical or different are as defined above for R_8 and R_{10} , and R_{25} , R_{26} and R_{27} which can be identical or different are C_2 - C_6 alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

2. A compound of the formula (I) according to claim 1, in which R_1 and R_3 are hydrogen, C_1 - C_4 alkyl, OH, C_6 - C_{12} alkoxy, C_5 - C_9 cycloalkoxy, allyl, benzyl or acetyl.

3. A compound of the formula (I) according to claim 1, in which X_1 and X_2 which can be identical or different are a group of the formula (II) in which R_2 is hydrogen, C_1 - C_{18} alkyl, C_5 - C_8 cycloalkyl unsubstituted or mono-, di- or tri-substituted by C_1 - C_4 alkyl; benzyl unsubstituted or mono-, di- or tri-substituted on the phenyl by C_1 - C_4 alkyl; tetrahydrofuryl, a group of the formula (III), C_2 - C_3 alkyl substituted in the 2- or 3-position by C_1 - C_4 alkoxy, by di- $(C_1$ - C_4 alkyl)amino or by a group of the formula (IV), where Q_1 is a direct bond, -O-, -CH₂- or -CH₂CH₂-, and A is -O- or



with R_4 being hydrogen or $\text{C}_1\text{-C}_{10}$ alkyl, or X_1 and X_2 are a group of the formula (IV) or one of the groups of the formulae (Va)-(Ve), in which R_6 , R_8 and R_7 which can be identical or different are as defined for R_2 , or R_7 is also $\text{C}_3\text{-C}_{12}$ alkenyl or phenyl unsubstituted or mono-, di- or tri-substituted by $\text{C}_1\text{-C}_4$ alkyl or $\text{C}_1\text{-C}_4$ alkoxy, Q_2 is $-\text{CO}-$, $-\text{CH}_2\text{CH}_2-$, $-\text{COCO}-$ or $-\text{COCH}_2\text{CO}-$, p is zero or 1 and n is 1, 2, 3 or 4, and, if n is 1, X_3 is as defined for X_1 and X_2 , and, if n is 2, X_3 is one of the groups of the formulae (VIa)-(VIc) in which R_8 , R_{10} and R_{12} which can be identical or different are as defined above for R_2 or R_8 and R_{10} are also a group of the formula (VII), R_9 is $\text{C}_2\text{-C}_{10}$ alkylene, cyclohexylene, cyclohexylenedimethylene, methylenedicyclohexylene, phenylenedimethylene, $\text{C}_4\text{-C}_{10}$ alkylene interrupted by a 1,4-piperazinediyl group or by 1, 2 or 3 oxygen atoms or by 1 or 2



groups, where R_{13} is as defined above for R_2 or is aliphatic $\text{C}_1\text{-C}_8$ acyl or $(\text{C}_1\text{-C}_8\text{alkoxy})\text{carbonyl}$, or R_9 is also a group

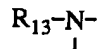


R_{11} and R_{14} are $\text{C}_2\text{-C}_4$ alkylene and q is zero or 1, and, if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb), in which R_{15} , R_{18} , R_{20} , R_{21} , R_{22} and R_{23} which can be identical or different are as defined above for R_8 and R_{10} , R_{16} , R_{17} and R_{19} which can be identical or different are $\text{C}_2\text{-C}_4$ alkylene, r and u are zero or 1 and s and t which can be identical or different are integers from 3 to 6 and, if n is 4, X_3 is a group of the formula (IX) in which R_{24} and R_{28} which can be identical or different are as defined above for R_8 and R_{10} , and R_{25} , R_{26} and R_{27} which can be identical or different are $\text{C}_2\text{-C}_4$ alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

4. A compound of the formula (I) according to claim 1, in which X_1 and X_2 which can be identical or different are a group of the formula (II), where R_2 is hydrogen, $\text{C}_1\text{-C}_{14}$ alkyl, cyclohexyl unsubstituted or mono-, di- or tri-substituted by $\text{C}_1\text{-C}_4$ alkyl; benzyl, tetrahydrofurfuryl, a group of the formula (III), $\text{C}_2\text{-C}_3$ alkyl substituted in the 2- or 3-position by methoxy, by ethoxy, by dimethylamino, by diethylamino or by a 4-morpholinyl group, and A is $-\text{O}-$ or



with R_4 being hydrogen or $\text{C}_1\text{-C}_8$ alkyl, or X_1 and X_2 are a 4-morpholinyl group or one of the groups of the formulae (Va)-(Ve) in which R_6 , R_8 and R_7 which can be identical or different are as defined above for R_2 , or R_7 is also $\text{C}_3\text{-C}_{11}$ alkenyl or phenyl, Q_2 is $-\text{CO}-$, $-\text{CH}_2\text{CH}_2-$ or $-\text{COCO}-$, p is zero or 1 and n is 1, 2, 3 or 4, and if n is 1, X_3 is as defined above for X_1 and X_2 , and, if n is 2, X_3 is one of the groups of the formulae (VIa)-(VIc) in which R_8 , R_{10} and R_{12} which can be identical or different are as defined above for R_2 , or R_8 and R_{10} are also a group of the formula (VII), R_9 is $\text{C}_2\text{-C}_8$ alkylene, cyclohexylenedimethylene, methylenedicyclohexylene, phenylenedimethylene, $\text{C}_4\text{-C}_{10}$ alkylene interrupted by a 1,4-piperazinediyl group or by 1, 2 or 3 oxygen atoms or by 1 or 2



groups, where R_{13} is as defined above for R_2 or is aliphatic $\text{C}_1\text{-C}_4$ acyl or $(\text{C}_1\text{-C}_4\text{alkoxy})\text{carbonyl}$, or R_9 is also a group



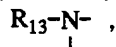
R_{11} and R_{14} are $\text{C}_2\text{-C}_4$ alkylene and q is zero or 1, and, if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb)

in which R_{15} , R_{18} , R_{20} , R_{21} , R_{22} and R_{23} which can be identical or different are as defined above for R_8 and R_{10} , R_{16} , R_{17} and R_{19} which can be identical or different are C_2 - C_4 alkylene, r and u are zero or 1 and s and t which can be identical or different are integers from 3 to 5, and, if n is 4, X_3 is a group of the formula (IX) in which R_{24} and R_{28} which can be identical or different are as defined above for R_8 and R_{10} , and R_{25} , R_{26} and R_{27} which can be identical or different are C_2 - C_4 alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

5. A compound of the formula (I) according to claim 1, in which X_1 and X_2 which can be identical or different are a group of the formula (II), where R_2 is hydrogen, C_1 - C_{12} alkyl, cyclohexyl or a group of the formula (III) and A is -O- or

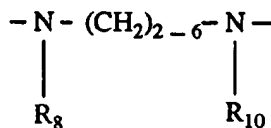


with R_4 being hydrogen or C_1 - C_4 alkyl, or X_1 and X_2 are a 4-morpholinyl group or one of the groups of the formulae (Va)-(Ve) in which R_5 , R_6 and R_7 which can be identical or different are as defined above for R_2 , Q_2 is -CO- or - CH_2CH_2 -, p is zero or 1 and n is 1, 2, 3 or 4, and, if n is 1, X_3 is as defined above for X_1 and X_2 , and, if n is 2, X_3 is one of the groups of the formulae (VIa)-(VIc) in which R_8 , R_{10} and R_{12} which can be identical or different are as defined above for R_2 , or R_8 and R_{10} are also a group of the formula (VII), R_9 is C_2 - C_6 alkylene, cyclohexylenedimethylene, methylenedicyclohexylene, C_6 - C_{10} alkylene interrupted by a 1,4-piperazinediyl group or by 2 or 3 oxygen atoms or by a group

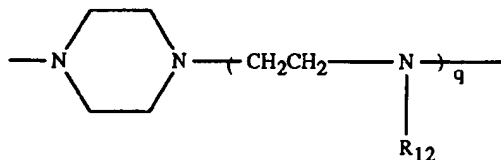


where R_{13} is as defined above for R_2 , R_{11} is C_2 - C_3 alkylene and q is zero or 1, and, if n is 3, X_3 is a group of the formula (VIIIa) or (VIIIb) in which r is zero, R_{15} , R_{18} , R_{21} , R_{22} and R_{23} , which can be identical or different are as defined above for R_8 and R_{10} , R_{16} and R_{17} which can be identical or different are C_2 - C_3 alkylene, u is zero or 1 and s and t which can be identical or different are integers from 3 to 5, and, if n is 4, X_3 is a group of the formula (IX) in which R_{24} and R_{28} which can be identical or different are as defined above for R_8 and R_{10} , and R_{25} , R_{26} and R_{27} which can be identical or different are C_2 - C_3 alkylene, with the proviso that at least one group of the formula (II) or of the formula (VII) is present in the compounds of the formula (I).

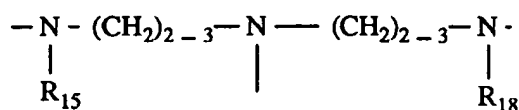
6. A compound of the formula (I) according to claim 1, in which X_1 and X_2 which can be identical or different are a group of the formula (II), where R_1 is hydrogen or methyl, R_2 is C_1 - C_8 alkyl, cyclohexyl, 2,2,6,6-tetramethyl-4-piperidyl or 1,2,2,6,6-pentamethyl-4-piperidyl and A is -O-, or X_1 and X_2 are a group of the formula (Va) or (Vb), in which R_5 and R_6 which can be identical or different are as defined above for R_2 , and R_7 is 2,2,6,6-tetramethyl-4-piperidyl or 1,2,2,6,6-pentamethyl-4-piperidyl and n is 1, 2, 3 or 4, and, if n is 1, X_3 is as defined above for X_1 and X_2 , and, if n is 2, X_3 is a group



or a group



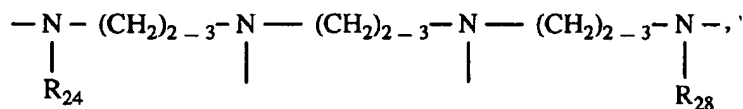
in which R_8 , R_{10} and R_{12} which can be identical or different are as defined above for R_2 or are hydrogen, or R_8 and R_{10} are also a group of the formula (VII), and q is zero or 1, and, if n is 3, X_3 is a group



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and, if n is 4, X₃ is a group

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with R₁₅, R₁₈, R₂₄ and R₂₈ being as defined above for R₈ and R₁₀, with the proviso that at least one group of the formula (II) or the formula (VII) is present in the compounds of the formula (I).

7. A composition which contains an organic material susceptible to degradation induced by light, heat and oxidation and at least one compound of the formula (I) according to claim 1.
8. A composition according to claim 7, wherein the organic material is a synthetic polymer.
9. A composition according to claim 8, which contains other conventional additives for synthetic polymers, in addition to the compounds of the formula (I).
10. A composition according to claim 7, wherein the organic material is a polyolefin.
11. A composition according to claim 7, in which the organic material is polyethylene or polypropylene.
12. A process for stabilizing an organic material against degradation induced by light, heat or oxidation, characterized in that at least one compound of the formula (I) defined in claim 1 is incorporated into or applied to this material.
13. The use of a compound of the formula (I) according to claim 1 for stabilizing an organic material against degradation induced by light, heat or oxidation.

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EUROPEAN SEARCH REPORT

Application Number
EP 94 81 0404

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	EP-A-0 328 024 (CIBA-GEIGY AG) 16 August 1989 *see especially Table on page 17 and formula VI on page 21* ---	1-13	C07D401/14 C08K5/3492
Y	GB-A-2 202 853 (CIBA-GEIGY AG) 5 October 1988 *see whole document, and especially pages 3 and 4* ---	1-13	
D,A	US-A-4 883 831 (R.V.NELSON ET AL) 28 November 1989 ---	1-13	
A	GB-A-2 134 112 (CIBA-GEIGY AG) 8 August 1984 ---	1-13	
D,A	US-A-4 102 858 (MOTONOBU MINAGAWA ET AL) 25 July 1978 *see examples* -----	1-13	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			C07D C08K
Place of search MUNICH		Date of completion of the search 20 October 1994	Examiner Scruton-Evans, I
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	
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